Fisheries and Oceans Canada | Pêches et Océans Canada

NOAA FISHERIES
NATIONAL MARINE FISHERIES SERVICE

CERT

Comité d'évaluation des ressources transfrontalières

Document de référence 2008/01

Ne pas citer sans autorisation des auteurs

TRAC

Transboundary Resources Assessment Committee

Reference Document 2008/01

Not to be cited without permission of the authors

ASSESSMENT OF EASTERN GEORGES BANK ATLANTIC COD FOR 2008

K. Clark[1], L. O'Brien[2], Y. Wang[1], S. Gavaris[1], and B. Hatt[1]

[1]Fisheries and Oceans Canada
531 Brandy Cove Road
St. Andrews, New Brunswick E5B 3L9
Canada

[2]NOAA/NMFS Northeast Fisheries Science Center
166 Water Street
Woods Hole, Massachusetts 02543-1097
USA

Ce document est disponible sur l'Internet à : This document is available on the Internet at :
http://www.mar.dfo-mpo.gc.ca/science/TRAC/trac.html

Canada

ABSTRACT

Combined Canada/USA catches, which averaged 17,500 mt between 1978 and 1992, peaked at 26,460 mt in 1982, declined to 1,804 mt in 1995, fluctuated around 3,000 mt until 2003 and subsequently declined again. Catches in 2007 were 1,796 mt, including 472 mt of discards. Canadian catches decreased to 1,232 mt in 2007 from 1,450 mt in 2006. USA catches increased to 564 mt in 2007 from 166 mt in 2006.

Adult population biomass declined substantially from 43,800 mt in 1990 to 8,500 mt in 1995, the lowest observed. The biomass subsequently increased to 19,400 mt in 2001, declined to 13,200 mt in 2005 but increased again to 19,300 mt at the beginning of 2008. Recruitment at Age 1 of the 2003 year class, at 7.1 million, is the only above average cohort since the 1990 year class. The 2002, 2004 and 2006 year classes, at less than 1 million each, are the lowest on record. Although the 2005 year class at 2.6 million fish at Age 1 is stronger than any of these cohorts, it is also below the 1978 to 2007 average.

Fishing mortality for ages 4-6 increased sharply between 1989 and 1993 from 0.5 to 1.0. Due to restrictive management measures, fishing mortality fluctuated between 0.19 and 0.50 during 1995 to 2004, and since 2005 has been at or below the Fref level of 0.18. In 2007 fishing mortality was 0.13.

Assuming a 2008 catch equal to the 2,300 mt total quota, a combined Canada/USA catch of about 2,100 mt in 2009 would result in a neutral risk (50%) that the fishing mortality rate in 2009 will exceed Fref , whereas a catch of 1,300 mt in 2009 would result in a neutral risk (50%) that the 2010 adult biomass will be lower than the 2009 adult biomass. A 10% biomass increase is unlikely even with no catch.

RÉSUMÉ

Les prises canado-américaines combinées, qui se chiffraient en moyenne à 17 500 t entre 1978 et 1992, ont culminé à 26 460 t en 1982, sont tombées à 1 804 t en 1995, puis ont fluctué alentour de 3 000 t jusqu'en 2003 et ont diminué à nouveau par la suite. Les prises de 2007 étaient de 1 796 t, dont 472 t de rejets. Les prises canadiennes ont diminué en 2007 par rapport à 2006, passant de 1 450 t à 1 232 t, alors que les prises américaines ont augmenté, passant de 166 t à 564 t.

La biomasse de la population d'adultes a considérablement diminué entre 1990 et 1995, de 43 800 t à 8 500 t. Ce niveau est le plus faible observé. La biomasse a augmenté par la suite (19 400 t en 2001), a diminué à nouveau (13 200 t en 2005) puis a augmenté une autre fois (19 300 t au début de 2008). Le recrutement, à l'âge 1, de la classe d'âge 2003, dont l'effectif se situe à 7,1 millions de sujets, représente l'arrivée de la première cohorte supérieure à la moyenne depuis la classe d'âge 1990. Les classes d'âge 2002, 2004 et 2006, qui se composent de moins de 1 million de sujets chacune, sont les plus basses observées à ce jour. Bien que la classe d'âge 2005, qui comprend 2,6 millions de sujets d'âge 1, soit la plus abondante de ces cohortes, ses effectifs se situent néanmoins aussi au-dessous de la moyenne pour la période 1978-2007.

La mortalité par pêche parmi les âges 4 à 6 a nettement augmenté entre 1989 et 1993, passant de 0,5 à 1,0. En raison de mesures de gestion restrictives, elle a fluctué entre 0,19 et 0,50 de 1995 à 2004. Depuis 2005, elle est égale ou inférieure à $F_{réf}$ de 0,18. En 2007, la mortalité par pêche était de 0,13.

En se fondant sur des prises hypothétiques égales au quota total de 2 300 t en 2008, des prises canado-américaines combinées d'environ 2 100 t en 2009 se traduiraient par un risque neutre (50 %) que le taux de mortalité par pêche en 2009 dépasse $F_{réf}$, tandis que des prises de 1 300 t se solderaient par un risque neutre (50 %) que la biomasse des adultes en 2010 soit inférieure à celle de 2009. Il est peu probable que la biomasse augmente de 10 %, même en l'absence de prises.

NOTE

After the completion, presentation and review of the 2008 assessment for 5Zjm cod, an error in the 2004 catch at age was noticed. This was corrected and the VPA was rerun. The updated catch at age led to slight changes in the VPA output and projections but did not change the outlook for the stock. The updated tables and risk plot are included in Appendix 2.

INTRODUCTION

For the purpose of developing a sharing proposal and consistent management by Canada and the USA, agreement was reached that the transboundary management unit for Atlantic cod would be limited to the eastern portion of Georges Bank (DFO Statistical Unit Areas 5Zj and 5Zm; USA Statistical Areas 551, 552, 561 and 562; Figure 1; DFO 2002). This assessment applied the benchmark formulation employed by Gavaris et al (2007a) using Canadian and USA fishery information updated to 2007, Fisheries and Oceans Canada (DFO) survey updated to 2008, National Marine Fisheries Services (NMFS) spring survey updated to 2008 and NMFS fall survey updated to 2007. Several other model formulations were explored and some preliminary results are presented.

FISHERY

Commercial Fishery Catches

Combined Canada/USA catches, which averaged 17,500 mt between 1978 and 1992, peaked at 26,460 mt in 1982, declined to 1,804 mt in 1995, fluctuated around 3,000 mt until 2003 and subsequently declined again. Catches in 2007 were 1,796 mt, including 472 mt of discards (Table 1, Figure 2). In this report, catches include USA and Canadian discards in all years where discard estimates were available.

Canadian catches peaked at 17,895 mt in 1982 and declined to 1,138 mt in 1995 (Table 1, Figure 2). Since 1995, with lower cod quotas, the fishery has reduced targeting for cod through changes in fishing practices. From 1995-2006 Canadian catches fluctuated between 861 mt and 3,404 mt. Landings in 2007 were 1,108 mt, taken primarily between June and December by otter trawl and longline (Table 2). All 2007 landings were subject to dockside monitoring and at sea observers monitored close to 99% by weight of the mobile gear fleet landings and 6% by weight of the fixed gear landings.

Discards from the Canadian groundfish fishery were estimated for 1997-1999 (Van Eeckhaute and Gavaris, 2004) and for 2005 and 2006 (Gavaris *et al.*, 2006, 2007b, 2007c) (Table 1). No discards were attributed to the Canadian mobile gear groundfish fishery due to the high observer coverage (99%). Discards from the Canadian fixed gear fleet could not be estimated because of low observer coverage, but they were assumed to be negligible, consistent with the observations from the 2006 fishery (Gavaris *et al.*, 2007b).

Since 1996 the Canadian scallop fishery has not been permitted to land cod. Landings until 1995 include those catches reported by the scallop fishery. Estimated discards of cod by the Canadian scallop fishery ranged up to 200 mt annually since 1978 (Van Eeckhaute *et al.*, 2005), and were 124 mt in 2007.

USA catches increased from 5,502 mt in 1978 to 10,551 mt in 1984, then declined and fluctuated around 6,000 mt between 1985 and 1993 (Table 1, Figure 2). Since December 1994, a year-round closure of Area II (Figure 1) has been in effect, with the exception of a Special Access Program for yellowtail flounder in 2004 and the scallop rotational management program in 2004, 2005, and 2006, and again in 2009. Minimum mesh size limits were increased in 1994, 1999 and in 2002. Limits on sea days, as well as trip limits, have also been implemented. USA catches during 1994-2000 ranged between 558 mt to 1,234 mt and increased to 1,900 mt in 2003. Quotas were introduced in May 2004. As in 2006, most of the 2007 catch was taken in the second quarter. Total USA catches were 564 mt in 2007 with 216 mt landed and estimated discards of cod in the groundfish fishery of 348 mt. Otter trawl gear accounted for 99% of the discards with scallop gear accounting for the remainder.

Size and Age Composition

The size and age compositions of the 2007 landings by the Canadian groundfish fishery were derived from port and at-sea samples from all principal gears and seasons (Table 3, Figure 3). Comparison of port and at-sea length frequencies did not indicate any discrepancies (Figure 4), except for a single fixed gear observed trip in November, which was not used in the catch at length because it appeared to be unrepresentative. With the exception of that trip, at-sea samples were pooled with port samples to derive catch at length and age. Landings peaked at 55 cm (22 in) for bottom trawlers (Figure 5) while longliners displayed a broader peak between 61 cm and 67 cm (24 to 27 in). Gill-netters caught fewer cod but these fish were larger, peaking at 79 cm (32 in). The size composition of cod discards from the 2007 Canadian scallop fishery was derived from at-sea sampling. Cod discards from the scallop fishery peaked at 49 cm (19 in) and tended to be smaller than cod caught by the groundfish fishery. The combined size composition peaked at 58 cm (23 in) (Figure 6).

There were sufficient samples from the 2007 USA fishery on eastern Georges Bank to characterize the size composition of the landings (Table 3). Landings peaked at 65 cm (26 in), whilst discards peaked at 53 and 59 cm (21 and 24 in) (Figure 7).

The 2007 catch composition of combined landings and discards for Canada and USA were similar (Figure 8). Age composition was obtained by applying quarterly fishery age-length keys to the size composition. Comparisons indicated good agreement between DFO and NMFS age readers (NEFSC, 2008) (Table 4). The age-length key from the 2007 DFO survey, conducted in February, was used to augment the first quarter key. The combined Canada/USA 2007 fishery age composition (Figure 9) was dominated by the 2003 year class at Age 4 (57% by number), whilst the 2001 year class at Age 6 made the second highest contribution (12% by number) and the incoming 2005 year class at Age 2 followed (11% by number). Where applicable, discards at age from the USA groundfish fishery (1989-2007), the Canadian groundfish fishery (1995-2007) and the Canadian scallop fishery (1978-2007) were included in the assessment. The catch at age for 1978-2006 was updated with the 2007 catch at age. The contribution of fish older than Age 7 to the catch continues to be small (Table 5, Figure 10).

Fishery weights at age show a declining trend starting in the early 1990s (Table 6, Figure 11). The 2007 fishery weights at age remained near the lowest observed since 1978 for all ages.

ABUNDANCE INDICES

Surveys

Surveys of Georges Bank have been conducted by DFO each year (February) since 1986 and by NMFS each autumn (October) since 1963 and each spring (April) since 1968. All surveys use a stratified random design (Figures 12 and 13). Most of the DFO surveys have been conducted by the *Alfred Needler*. A sister ship, the *Wilfred Templeman*, conducted the survey in 1993, 2004, 2007 and 2008 and another vessel, the *Teleost*, conducted 6 of the sets in 2006. No conversion factors were applied. For the NMFS surveys, the *Albatross IV* and the *Delaware II* vessels have both been employed and there was a change in the trawl doors in 1985. Vessel and door type conversion factors derived experimentally from comparative fishing (Forrester *et al.* 1997) have been applied to the survey results to make the series consistent (Table 7). Additionally, two different trawl nets have been used on the NMFS spring survey, a modified Yankee 41 from 1973-81 and a Yankee 36 in other years, but no conversion factors are available for cod.

The spatial distribution of ages 3 and older cod caught during the 2008 DFO survey was similar to those observed from surveys over the previous decade (Figure 14) with some of the highest densities observed on the northern part of the bank. Total catch in numbers in the 2008 DFO survey increased slightly from 2006 and 2007 with strong representation by the 2003 year class at Age 5 (Table 8). The 2008 NMFS spring survey distribution of cod also showed a similar distribution pattern relative to the previous decade (Figure 15). Total catch in numbers for the NMFS spring survey decreased between 2007 and 2008, although the 2003 year class was still strongly represented in the most recent survey (Table 9). The high index observed in 2004 appears to be a year effect. The 2007 NMFS autumn survey caught very few cod (29 in total). The limited catch was in locations similar to the pattern observed during the previous decade (Figure 16). Total catch in numbers in the 2007 NEFSC autumn survey was the second lowest in the survey time series (Table 10).

With the exception of the 2003 year class, the survey abundance at age (Table 8-10, Figure 17) shows poor recruitment since the 1990 year class. The 2003 year class appears good, particularly in the DFO survey. There are few fish at older ages in recent years.

Weights at age derived from the DFO survey (Table 11, Figure 11) and the NMFS spring survey (Figure 11) display a declining trend since the early 1990s. Cod condition, derived from the DFO survey and measured as average weight at length at 3 representative length groupings, did not show any notable trends (Figure 18).

HARVEST STRATEGY

The Transboundary Management Guidance Committee has adopted a strategy to maintain a low to neutral risk of exceeding the fishing mortality limit reference, $F_{ref} = 0.18$. When stock conditions are poor, fishing mortality rates should be further reduced to promote rebuilding.

ESTIMATION AND DIAGNOSTICS

Evaluation of the state of the resource was based on results from an age structured analytical assessment (Virtual Population Analysis, VPA), which used fishery catch statistics and sampling for size and age composition of the catch for 1978 to 2007 (including discards). The VPA was

calibrated to trends in abundance from three bottom trawl survey series: NMFS spring, NMFS fall and DFO.

A consensus model formulation was established during the benchmark assessment review (NEFSC 2002). The adaptive framework, ADAPT, (Gavaris 1988) was used to implement the benchmark formulation for calibrating the virtual population analysis with the research survey data. Computational formulae used in ADAPT are described by Rivard and Gavaris (2003a). The data used in the model were:

$C_{a,t}$ = catch at age for ages a = 1 to 10 and time t = 1978 to 2007, where t represents the year during which the catch was taken

$I_{1,a,t}$ = DFO survey for ages a = 2 to 7 and time t = 1986.17, 1987.17... 2007.17, 2008.00

$I_{2,a,t}$ = NMFS spring survey (Yankee 41) for ages a = 1 to 8 and time t = 1978.28, 1979.28, 1980.28, 1981.28

$I_{3,a,t}$ = NMFS spring survey (Yankee 36), for ages a = 1 to 8 and time t = 1982.28, 1983.28... 2007.28, 2008.00

$I_{4,a,t}$ = NMFS autumn survey, ages a = 1 to 5 and time t = 1978.79, 1979.79... 2007.79.

The population was calculated to the beginning of 2008.00, therefore the DFO and NMFS spring survey indices for 2008 were designated as occurring at the beginning of the year, i.e. 2008.00. The benchmark formulation assumed that observation errors for the catch at age data were negligible. Observation errors for the abundance indices at age were assumed to be independent and identically distributed after taking natural logarithms of the values. Zero observations for abundance indices were treated as missing data as the logarithm of zero is not defined. The annual natural mortality rate, M, was assumed constant and equal to 0.2 for all ages in all years. Fishing mortality on Age 10 for 1978 to 1997 was assumed to be equal to the population number weighted average fishing mortality on ages 8 and 9.

Estimation was based on minimization of the objective function:

$\sum_{s,a,t}\left(lnI_{s,a,t} - \left(\hat{\kappa}_{s,a} + v_{a,t}\right)\right)^2$, where s indexes survey.

The estimated model parameters were:

$v_{a,t} = lnN_{a,t} = ln$ population abundance for a = 2 to 11 at time t = 2007 and for a = 11 at time t = 1999 to 2008

$\kappa_{1,a} = ln$ DFO survey catchability for a = 2 to 7

$\kappa_{2,a} = ln$ NMFS spring survey (Yankee 41) catchability for ages a = 1 to 8

$\kappa_{3,a} = ln$ NMFS spring survey (Yankee 36) catchability for ages a = 1 to 8

$\kappa_{4,a} = ln$ NMFS autumn survey catchability for ages a = 1 to 5.

Statistical properties of estimators were determined using conditional non-parametric bootstrapping of model residuals (Efron and Tibshirani 1993, Rivard and Gavaris 2003a). The population abundance estimate at Age 3 at the beginning of 2008 exhibited the largest relative bias of 17%, while that for other ages/times ranged between 3% and 10%. The relative error ranged between 30% and 70% (Table 12). Survey catchability (q) at age for the DFO and NMFS spring (Yankee 36) surveys progressively increased until about Age 5 and then declined. Survey catchability at age for the NMFS autumn survey was highest at Age 3. When survey catchability was examined by age, both the DFO and NMFS spring surveys showed a domed trend in q with increasing age (Figure 19). While trends in the surveys were generally consistent, the survey indices exhibit high variability and the average magnitude of residuals is large. Some patterns in the residuals suggest year effects (Figure 20). The overall fit of model estimated biomass and recruitment to the DFO, NMFS spring and NMFS fall surveys was good but the estimated biomass prior to the mid 1990s had a tendency to be higher than the surveys indicated (figures 21-23).

Retrospective analyses were used to detect any patterns to consistently overestimate or underestimate fishing mortality, biomass and recruitment relative to the terminal year estimates. The extent of the pattern for this assessment was similar to that seen in the past and was not of concern (figures 24-25), though there was a general tendency to initially underestimate some recent year-classes as recruits at Age 1 (Figure 26).

STATE OF RESOURCE

The beginning of year population abundance, fishing mortality and beginning of year population biomass produced by the benchmark method are shown in Table 13-15. Partial recruitment (PR) is shown in Figure 27. This method shows strongly domed PRs since 1995, and therefore imputes that there are older fish in the population.

There are some concerns regarding the currently accepted benchmark model formulation. In 2002 this formulation displayed a desirable feature, a flat pattern for survey catchability at older ages. However, it now shows a domed catchability for older ages in both the DFO and NMFS spring surveys. In combination with the domed fishery partial recruitment for older ages, this generates 'cryptic' biomass that is not observed in either the fishery or the surveys. This can lead to an overestimation of fish at older ages. A preliminary examination was made of a number of other model formulations (Appendix 1) but there were also issues with these alternative formulations that were not fully resolved, and all generated lower biomass and lower projected catches than the current benchmark formulation. Some of the alternative formulation results were similar, but the most pessimistic (from splitting the survey indices in 1994) were about half the 3+ biomass and projected catch of the benchmark formulation results. The 2002 benchmark formulation was used as the basis for management advice.

Based on the results from the benchmark formulation, recruitment at Age 1 of the 2003 year class, at 7.1 million, is the only above average (6.0 million for 1978-2007) cohort since the 1990 year class (Table 13, Figure 28). The 2002, 2004 and 2006 year classes, at less than 1 million each, are the lowest on record. Although the 2005 year class, at 2.6 million fish at Age 1, is stronger than any of these cohorts, it too is below the 1978 to 2007 average.

Fishing mortality (population weighted average) for ages 4-6 increased sharply between 1989 and 1993 from 0.46 to 1.0 (Table 14, Figure 29). Due to restrictive management measures, fishing mortality fluctuated between 0.19 and 0.50 during 1995 to 2004, declined to 0.12 in

2005, and has subsequently been at or below the F_{ref} level of 0.18. Fishing mortality in 2007 was 0.13 (80% Confidence Interval: 0.10 – 0.18).

Adult population biomass (ages 3+) declined substantially from 43,800 mt in 1990 to 8,500 mt in 1995, the lowest observed (Table 15, Figure 28). The biomass subsequently increased to 19,400 mt in 2001, declined to 13,200 mt in 2005 but increased again to 19,300 mt at the beginning of 2008 (80% Confidence Interval: 16,300 mt to 23,600 mt). Much of the increase in the late 1990's was the result of growth and survival to ages 5+ of the 1992, 1995 and 1996 year classes. The increase in 2006 was due largely to recruitment of the 2003 year class, and the increases in 2007 and 2008 were due to growth of the 2003 year class. All subsequent year classes have been below the 1978 to 2007 average. Lower weights-at-age in the population in recent years and generally poor recruitment have contributed to the lack of sustained rebuilding.

Yield exceeded surplus production during the early 1990s (Figure 30). Surplus production since the mid 1990s has remained considerably lower than that prior to 1990. Growth of ages 2 to 10 has typically accounted for the greatest percentage of the production (Figure 31). Occasionally, a strong incoming year-class at Age 2 makes a greater contribution to production. The 2003 year class made such a contribution in 2005. While there has been a tendency for greater chance of good recruitment when biomass exceeded 25,000 mt (Figure 32), there is high recruitment variability at any given biomass. Since the early 1990s, biomass has remained below 25,000 mt and recruitment has been poor.

PRODUCTIVITY

Recruitment, as well as age structure, fish growth and spatial distribution reflect changes in the productive potential. In both absolute numbers and percent composition, the population age structure displays a higher abundance at older age groups compared to the mid 1990s. However, the abundance for older ages may not be well determined and may be inflated by the model formulation. Average weight at length, used to reflect condition, has been stable, but declines in length and weight at age have hampered biomass rebuilding. The spatial distribution patterns observed during the most recent bottom trawl surveys showed that adult cod were distributed in a similar manner to the average over the past decade. Resource productivity is currently poor due to low recent recruitment and low weights at age.

OUTLOOK

This outlook is provided in terms of consequences with respect to the harvest reference points for alternative catch quotas in 2009 (Rivard and Gavaris 2003b). Uncertainty about standing stock generates uncertainty in forecast results which is expressed here as the risk of exceeding F_{ref} =0.18. The risk calculations assist in evaluating the consequences of alternative catch quotas by providing a general measure of the uncertainties. However, they are dependent on the data and model assumptions and do not include uncertainty due to variations in weight at age, partial recruitment to the fishery, natural mortality, systematic errors in data reporting or the possibility that the model may not reflect stock dynamics closely enough.

For projections, the 2005-2007 average values were assumed for the fishery weight at age and the 2003-2007 average values were assumed for the partial recruitment pattern in 2008-2009 and the 2006-2008 survey average values were assumed for beginning of year population weight at age in 2009-2010 (Table 16). Assuming a 2008 catch equal to the 2,300 mt total

quota, a combined Canada/USA catch of about 2,100 mt in 2009 will result in a neutral risk (50%) that the fishing mortality rate in 2009 will exceed F_{ref} whereas a catch of 1,300 mt will result in a neutral risk (50%) that the 2010 adult biomass will be lower than the 2009 adult biomass (Figure 33). A 10% biomass increase is unlikely even with no catch.

The 2003 year class is projected to continue to contribute over 50% of the fishery catch biomass in 2008 and 2009 (Table 17). With well below average 2004 and 2006 year classes, exploitation below F_{ref} would maintain biomass at a higher level in the near future, increasing chances of better recruitment.

REFERENCES

DFO, 2002. Development of a sharing allocation proposal for transboundary resources of cod, haddock and yellowtail flounder on Georges Bank. DFO Maritime Provinces, Regional Fisheries Management Report 2002/01: 59p. http://www.mar.dfo-mpo.gc.ca/science/tmgc/background/FMR 202002_01.pdf

Efron, B., and R.J. Tibshirani. 1993. An introduction to the bootstrap. Chapman & Hall. New York. 436p.

Forrester, J.R.S., C.J. Byrne, M.J. Fogarty, M.P. Sissenwine, and E.W. Bowman. 1997. Background papers on USA vessel, trawl, and door conversion studies. SAW/SARC 24 Working Paper Gen 6. Northeast Fisheries Science Center, Woods Hole, MA.

Gavaris, S. 1988. An adaptive framework for the estimation of population size. CAFSAC Res. Doc. 88/29: 12p.

Gavaris, S., L. O'Brien, B. Hatt, and K. Clark. 2006. Assessment of eastern Georges Bank cod for 2006. TRAC Ref. Doc. 2006/05: 48p.

Gavaris, S., L. O'Brien, K. Clark, and B. Hatt. 2007a. Assessment of eastern Georges Bank cod for 2007. TRAC Ref. Doc. 2007/04: 47p.

Gavaris, S., L. Van Eeckhaute, and K. Clark. 2007b. Discards of cod from the 2006 Canadian groundfish fishery on eastern Georges Bank. TRAC Ref. Doc. 2007/02: 19p.

Gavaris, S., G. Robert, and L. Van Eeckhaute. 2007c. Discards of Atlantic cod, haddock and yellowtail flounder from the 2005 and 2006 Canadian scallop fishery on Georges Bank. TRAC Ref. Doc. 2007/03: 10p.

NEFSC. 2002. O'Boyle, R.N., and W.J. Overholtz, editors. Proceedings of the fifth meeting of the Transboundary Resources Assessment Committee (TRAC), Woods Hole, Massachusetts, February 5-8, 2002. Northeast Fish. Sci. Cent. Ref. Doc. 02-12: 56p.

NEFSC. 2008. Results of all QA/QC exercises for cod, *Gadus morhua*. http://www.nefsc.noaa.gov/fbi/QA-QC/cod-results.html.

Rivard, D., and S. Gavaris. 2003a. St. Andrews (S. Gavaris) version of ADAPT: Estimation of population abundance. NAFO Sci. Coun. Studies 36: 201-249.

Rivard, D., and S. Gavaris. 2003b. Projections and risk analysis with ADAPT. NAFO Sci. Coun. Studies 36: 251-271.

Van Eeckhaute, L., and S. Gavaris. 2004. Determination of discards of Georges Bank cod from species composition comparison. TRAC Ref. Doc. 2004/04: 27p.

Van Eeckhaute, L., S. Gavaris, and H.H. Stone. 2005. Estimation of cod, haddock and yellowtail flounder discards from the Canadian Georges Bank scallop fishery for 1960 to 2004. TRAC Ref. Doc. 2005/02: 18p.

Table 1. Catches (mt) of cod from eastern Georges Bank, 1978-2007.

	Canada			USA			Total
Year	Landings	Discards	Total	Landings	Discards	Total	
1978	8,778	98	8,876	5,502		5,502	14,378
1979	5,978	103	6,081	6,408		6,408	12,489
1980	8,063	83	8,146	6,418		6,418	14,564
1981	8,499	98	8,597	8,094		8,094	16,691
1982	17,824	71	17,895	8,565		8,565	26,460
1983	12,130	65	12,195	8,572		8,572	20,767
1984	5,763	68	5,831	10,551		10,551	16,382
1985	10,443	103	10,546	6,641		6,641	17,187
1986	8,504	51	8,555	5,696		5,696	14,251
1987	11,844	76	11,920	4,792		4,792	16,712
1988	12,741	83	12,824	7,645		7,645	20,469
1989	7,895	76	7,971	6,182	158	6,340	14,311
1990	14,364	70	14,435	6,378	61	6,439	20,873
1991	13,462	65	13,526	6,777	144	6,921	20,448
1992	11,673	71	11,744	5,080	129	5,209	16,953
1993	8,524	63	8,586	4,019	66	4,085	12,671
1994	5,278	63	5,340	1,228	6	1,234	6,575
1995	1,100	38	1,138	665	1	666	1,804
1996	1,926	56	1,982	773	2	775	2,757
1997	2,919	486	3,404	557	1	558	3,963
1998	1,907	365	2,272	795	2	797	3,069
1999	1,818	338	2,156	1,150	7	1,157	3,314
2000	1,572	69	1,641	661	11	672	2,313
2001	2,143	143	2,285	1,361	83	1,444	3,730
2002	1,279	94	1,373	1,379	37	1,416	2,789
2003	1,325	200	1,525	1,813	87	1,900	3,425
2004	1,111	145	1,257	980	74	1,053	2,310
2005	630	231	861	124	153	277	1,139
2006	1,096	354	1,450	79	87	166	1,615
2007	1,108	124	1,232	216	348	564	1,796
Minimum	630	38	861	79	0	208	1,248
Maximum	17,824	486	17,895	10,551	348	10,551	26,460
Average	6,390	132	6,522	3,970	105	4,037	10,558

Table 2. Nominal landings (mt) of cod from eastern Georges Bank by gear and month for Canada during 1998-2007.

Year	Gear	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1998	Gillnet						76	90	63	25	46			300
	Longline						74	345	221	197	87	21	18	963
	Mobile						178	71	138	95	99	39	27	645
	Total					**0**	**328**	**505**	**422**	**316**	**232**	**60**	**45**	**1907**
1999	Gillnet						59	100	48	15	36	7	6	270
	Longline						95	288	244	152	107	27	17	929
	Mobile	3					226	156	47	72	59	38	19	619
	Total	**3**					**379**	**544**	**339**	**239**	**201**	**71**	**42**	**1818**
2000	Gillnet						55	76	28	24	41	9	4	238
	Longline						41	191	177	222	138	15	16	800
	Mobile	0					102	140	82	73	70	38	30	535
	Total	**0**					**197**	**407**	**287**	**318**	**248**	**63**	**51**	**1572**
2001	Gillnet						37	75	48	60	43	21		284
	Longline						62	212	273	282	229	62	16	1137
	Mobile						160	84	58	104	134	111	72	722
	Total						**259**	**371**	**379**	**446**	**406**	**193**	**89**	**2143**
2002	Gillnet						3	45	51	23	1	9	7	140
	Longline						2	151	199	162	127	31	30	700
	Mobile						38	87	34	78	62	55	86	439
	Total						**43**	**283**	**283**	**263**	**190**	**95**	**123**	**1279**
2003	Gillnet						6	30	31	24	3	14	1	110
	Longline						22	181	238	138	121	28	14	742
	Mobile						88	84	54	64	69	70	45	474
	Total						**116**	**295**	**324**	**227**	**193**	**112**	**59**	**1325**
2004	Gillnet						4	2	14	21	0	11	0	52
	Longline						6	85	231	168	88	96	14	688
	Mobile						78	82	50	47	56	42	16	371
	Total						**88**	**169**	**294**	**236**	**144**	**149**	**30**	**1111**
2005	Gillnet	0	0			0	11	18	0	6	0	0	0	36
	Longline	1	0			0	9	44	101	71	52	29	4	311
	Mobile	12	22			3	50	49	31	27	28	31	30	283
	Total	**13**	**22**			**3**	**70**	**111**	**133**	**105**	**80**	**60**	**34**	**630**
2006	Gillnet						0	27	15					43
	Longline	3					10	135	180	139	81	34	14	595
	Mobile	42	16				93	73	78	58	36	25	38	458
	Total	**45**	**16**	**0**	**0**	**0**	**104**	**235**	**273**	**197**	**117**	**59**	**52**	**1096**
2007	Gillnet						1	4	41	13				59
	Longline						9	118	169	219	103	39		657
	Mobile	80	7				48	84	52	35	47	12	28	392
	Total	**80**	**7**	**0**	**0**	**0**	**57**	**206**	**262**	**266**	**150**	**51**	**28**	**1108**

Table 3. Commercial landings length and age samples from 1978-2007 for eastern Georges Bank Canadian and USA cod fisheries. At-sea observer samples are included in Canadian length samples since 1994 (each trip counted as one sample). Canadian fishery age samples for the first quarter of 2005-2007 were supplemented with DFO survey age samples. USA age samples for 1996-2006 were supplemented with Canadian age samples. The number after supplementing is shown in brackets.

	USA			Canada		
Year	Samples	Lengths	Ages	Samples	Lengths	Ages
1978	29	2,047	385	29	7,684	1,308
1979	21	1,833	402	13	3,991	656
1980	16	1,258	286	10	2,784	536
1981	21	1,615	456	17	4,147	842
1982	45	4,111	778	17	4,756	858
1983	40	3,775	903	15	3,822	604
1984	44	3,891	1,130	7	1,889	385
1985	23	2,076	597	18	7,644	1,062
1986	27	2,145	644	19	5,745	888
1987	23	1,865	525	33	9,477	1,288
1988	37	3,229	797	43	11,709	1,984
1989	19	1,572	251	32	8,716	1,561
1990	28	1,989	287	40	9,901	2,012
1991	23	1,894	397	45	10,873	1,782
1992	25	2,048	445	48	10,878	1,906
1993	29	2,215	440	51	12,158	2,146
1994	13	1,323	260	104	25,845	1,268
1995	-	-	-	36	11,598	548
1996	3	284[1]	74 (953)	129	26,663	879
1997	80	6,638[1]	55 (1,299)	118	31,882	1,244
1998	82	7,076[1]	46 (1,766)	139	26,549	1,720
1999	70	6,045[1]	250 (1,168)	84	24,954	918
2000	156	12,219[1]	41 (1,551)	107	20,782	1,436
2001	108	8,389[1]	351 (2,423)	108	18,190	1,509
2002	86	6,306[1]	378 (1,642)	91	18,974	1,264
2003	47	2,785[1]	385 (1,569)	94	20,199	1,070
2004	31	1,872[1]	439 (1,481)	127	17,859	1,370
2005	58	2,160[1]	249(1,511)	136	21,942	786(1,483)
2006	34	2,156[1]	129(1,651)	258	43,259	807(1,455)
2007	7	871	288	494	139,816	1,216(1,672)

[1] Includes length samples from western Georges Bank.

Table 4. Results of recent age comparison testing.

Sample Source	Stock	Test Type	Date Completed	Age Reader	Sample Size	CV (%)	Agreement (%)
2007 Commercial Samples (Q1-2)	GB	Exchange	Spring 2008	NS vs. BH	99	1.8	88.9
2006 NMFS Fall Survey (200610)	GB	Exchange	Spring 2008	NS vs. BH	60	2.83	88.3
2007 Commercial Samples (Q3-4)		Precision	Jun-08	NS	81	0.35	97.5
2007 Commercial Samples (Q1-2)		Precision	Jun-08	NS	100	0.13	99
Cod Reference Collection	GB	Accuracy	Jun-08	NS	75	0.27	98.7
2008 NMFS Spring Survey (200803)		Precision	Jun-08	NS	100	0.11	99
2007 NMFS Fall Survey (200709)		Precision	Jun-08	NS	50	0	100
Intra Aging Tests Qtr 1-4 2006-07	GB	Precision	Apr-08	BH	192	0.66	95
DFO Winter Survey TEM2007685	GB	Exchange	Jan-09	BH vs NS	50		82

Table 5. Annual catch at age numbers (thousands) for eastern Georges Bank cod.

Year	Age Group										
	1	2	3	4	5	6	7	8	9	10	1+
1978	2.0	121.0	3588.0	1076.0	307.0	110.0	83.0	21.0	11.6	3.6	5327
1979	10.2	827.6	405.7	1803.7	554.1	151.5	22.4	45.8	3.8	3.1	3829
1980	1.0	994.3	1506.1	267.0	922.8	347.6	109.8	20.1	33.6	5.4	4212
1981	19.2	609.0	1457.3	1261.3	156.5	600.9	170.7	65.6	36.4	18.6	4396
1982	6.0	2692.7	1692.7	1434.7	1070.2	189.8	346.4	157.6	37.2	12.2	7665
1983	40.1	1322.4	3424.7	1477.8	467.2	283.7	31.1	71.2	38.9	5.9	7173
1984	10.1	270.6	916.5	1354.2	514.1	291.8	231.4	31.2	72.8	26.6	3744
1985	12.1	2804.8	1226.6	633.9	945.3	225.0	96.4	100.5	14.4	26.9	6095
1986	28.2	328.5	2204.8	516.9	306.3	403.1	58.4	39.3	25.9	3.6	3925
1987	14.0	3665.8	864.9	1098.9	144.0	121.0	167.0	37.0	23.6	7.6	6147
1988	9.9	317.3	3621.9	640.5	853.7	142.8	101.1	141.8	40.5	19.4	5906
1989	48.8	820.1	667.0	1827.6	191.8	311.7	55.6	24.8	50.9	11.7	4021
1990	9.0	719.5	3215.2	965.9	1199.1	116.4	122.3	10.0	14.3	22.6	6403
1991	33.3	724.1	802.4	1944.5	953.3	790.4	93.0	56.0	17.8	7.1	5434
1992	96.9	2456.9	1252.0	432.1	906.9	249.8	232.8	25.0	26.8	2.4	5686
1993	7.6	458.9	1986.2	812.3	216.1	333.7	110.6	93.6	23.2	17.4	4062
1994	2.9	187.5	488.5	753.0	246.5	40.7	58.8	26.0	20.3	1.1	1826
1995	2.0	56.5	235.2	120.1	89.1	14.4	4.2	3.0	1.5	0.0	526
1996	4.4	41.7	238.5	400.3	78.8	49.8	11.8	2.7	1.8	0.1	830
1997	3.0	136.2	213.7	412.0	461.1	111.8	55.7	18.5	3.7	0.7	1417
1998	0.6	103.2	381.1	198.1	201.2	167.0	26.2	14.9	4.7	1.1	1100
1999	3.3	63.0	540.4	364.4	110.1	61.7	52.1	12.1	2.1	4.6	1214
2000	1.8	59.6	115.8	335.9	129.5	34.6	20.2	12.2	1.8	0.3	712
2001	1.9	112.9	471.5	201.2	375.3	98.4	29.3	17.1	5.4	0.5	1314
2002	3.9	16.5	130.5	377.6	98.0	145.7	25.8	7.5	3.8	1.5	811
2003	1.8	31.6	177.9	276.5	393.6	73.0	81.9	15.9	3.1	1.2	1057
2004	2.9	13.7	132.7	152.3	134.0	128.8	32.9	22.1	4.3	0.8	625
2005	1.7	88.4	56.3	192.8	56.3	31.3	39.8	10.9	5.2	1.3	484
2006	5.8	19.6	251.2	78.3	188.1	48.3	18.2	16.9	2.4	1.3	631
2007	2.1	76.3	84.1	404.9	30.3	85.9	11.0	7.4	6.6	0.5	709

Table 6. Average fishery weights at age (kg) of cod from eastern Georges Bank.

Year	Age Group									
	1	2	3	4	5	6	7	8	9	10
1978	0.71	1.31	2.46	3.47	4.34	5.79	7.37	8.49	11.79	13.62
1979	0.89	1.49	2.15	4.21	4.89	7.18	9.18	10.31	11.70	14.06
1980	0.84	1.46	2.47	3.67	5.65	6.68	8.39	9.09	8.43	14.35
1981	0.88	1.50	2.36	3.42	5.21	7.22	8.57	9.89	14.17	13.57
1982	0.77	1.40	2.66	3.83	5.35	6.51	9.36	9.90	12.50	13.68
1983	0.97	1.49	2.38	3.31	4.64	6.39	7.96	10.29	11.23	12.21
1984	1.05	1.64	2.45	3.62	5.08	6.58	8.91	10.10	11.30	13.79
1985	0.91	1.42	2.09	3.89	5.09	6.41	8.10	10.24	11.42	12.72
1986	0.93	1.48	2.45	3.66	5.60	7.19	8.92	9.96	12.69	8.91
1987	0.73	1.48	2.50	4.19	5.81	7.73	8.95	10.01	11.41	13.93
1988	0.79	1.52	2.36	3.51	5.40	6.65	8.78	9.99	11.14	13.17
1989	0.81	1.62	2.27	3.77	5.40	6.69	8.22	10.72	11.67	14.14
1990	0.83	1.56	2.46	3.52	4.89	6.33	8.46	10.65	12.58	14.04
1991	1.11	1.63	2.55	3.42	4.77	6.89	7.41	10.52	9.69	14.52
1992	1.15	1.54	2.46	3.84	4.70	6.16	7.51	9.85	12.06	14.52
1993	0.88	1.57	2.31	3.08	4.50	5.73	7.08	8.88	9.70	10.86
1994	0.91	1.46	2.41	3.83	4.80	7.09	7.86	8.93	9.70	10.37
1995	0.90	1.49	2.51	3.72	5.22	6.52	11.06	10.12	10.38	14.52
1996	1.03	1.54	2.36	3.34	5.24	6.36	6.92	8.46	12.88	10.51
1997	0.98	1.50	2.23	3.34	4.25	5.80	8.05	8.33	11.87	14.52
1998	0.63	1.48	2.37	3.19	4.27	5.83	6.99	8.30	12.68	11.81
1999	0.80	1.55	2.29	3.53	4.16	6.31	6.78	8.04	12.15	13.54
2000	0.87	1.46	2.13	3.08	4.23	4.92	6.20	7.34	8.27	12.97
2001	0.88	1.49	2.33	3.00	4.05	5.12	5.08	8.02	9.22	14.81
2002	0.55	1.42	2.27	3.08	4.30	5.07	6.75	8.28	8.82	8.46
2003	0.26	1.66	2.15	2.67	3.68	4.35	5.67	7.29	7.86	9.02
2004	0.70	1.37	2.03	2.87	3.45	4.57	5.50	7.35	9.03	8.86
2005	0.17	0.91	1.53	2.43	3.50	4.50	4.87	6.80	7.98	8.69
2006	0.19	0.69	1.74	2.35	3.37	4.26	6.12	5.80	6.87	7.43
2007	0.48	1.09	1.57	2.41	3.07	3.97	6.28	6.80	6.88	9.30
Min.	0.17	0.69	1.53	2.35	3.07	3.97	4.87	5.80	6.87	7.43
Max.	1.15	1.66	2.66	4.21	5.81	7.73	11.06	10.72	14.17	14.81
Avg.[1]	0.36	1.14	1.80	2.55	3.42	4.33	5.69	6.81	7.72	8.66

[1]for 2003-2007

Table 7. Conversion factors used to adjust for changes in door type and survey vessel for the NMFS surveys.

Year	Door	Spring		Fall	
		Vessel	Conversion	Vessel	Conversion
1978	BMV	Albatross IV	1.56	Delaware II	1.2324
1979	BMV	Albatross IV	1.56	Delaware II	1.2324
1980	BMV	Albatross IV	1.56	Delaware II	1.2324
1981	BMV	Delaware II	1.2324	Delaware II	1.2324
1982	BMV	Delaware II	1.2324	Albatross IV	1.56
1983	BMV	Albatross IV	1.56	Albatross IV	1.56
1984	BMV	Albatross IV	1.56	Albatross IV	1.56
1985	Polyvalent	Albatross IV	1	Albatross IV	1
1986	Polyvalent	Albatross IV	1	Albatross IV	1
1987	Polyvalent	Albatross IV	1	Albatross IV	1
1988	Polyvalent	Albatross IV	1	Albatross IV	1
1989	Polyvalent	Delaware II	0.79	Delaware II	0.79
1990	Polyvalent	Delaware II	0.79	Delaware II	0.79
1991	Polyvalent	Delaware II	0.79	Delaware II	0.79
1992	Polyvalent	Albatross IV	1	Albatross IV	1
1993	Polyvalent	Albatross IV	1	Delaware II	0.79
1994	Polyvalent	Delaware II	0.79	Albatross IV	1
1995	Polyvalent	Albatross IV	1	Albatross IV	1
1996	Polyvalent	Albatross IV	1	Albatross IV	1
1997	Polyvalent	Albatross IV	1	Albatross IV	1
1998	Polyvalent	Albatross IV	1	Albatross IV	1
1999	Polyvalent	Albatross IV	1	Albatross IV	1
2000	Polyvalent	Albatross IV	1	Albatross IV	1
2001	Polyvalent	Albatross IV	1	Albatross IV	1
2002	Polyvalent	Albatross IV	1	Albatross IV	1
2003	Polyvalent	Delaware II	0.79	Delaware II	0.79
2004	Polyvalent	Albatross IV	1	Albatross IV	1
2005	Polyvalent	Albatross IV	1	Albatross IV	1
2006	Polyvalent	Albatross IV	1	Albatross IV	1
2007	Polyvalent	Albatross IV	1	Albatross IV	1
2008	Polyvalent	Albatross IV	1		

Table 8. Indices of abundance (numbers/standard tow) of eastern Georges Bank cod from the DFO survey.

	Age Group										
Year	0	1	2	3	4	5	6	7	8	9+	Total
1986	0.00	1.78	8.19	7.41	0.77	1.60	1.03	0.51	0.08	0.00	21.37
1987	0.00	0.12	4.31	1.55	1.81	0.39	0.21	0.44	0.21	0.13	9.18
1988	0.00	0.36	1.08	12.85	1.36	2.02	0.23	0.19	0.43	0.12	18.64
1989	0.00	0.84	5.22	1.84	4.11	0.62	0.80	0.10	0.20	0.39	14.13
1990	0.05	0.25	1.91	8.36	4.70	10.60	1.29	2.63	0.35	1.46	31.60
1991	0.00	2.88	2.45	3.39	3.95	2.12	2.88	0.36	0.60	0.33	18.96
1992	0.00	0.11	4.93	2.94	0.99	1.55	1.09	0.72	0.22	0.15	12.70
1993	0.00	0.07	0.85	4.15	1.50	0.89	1.82	0.66	0.64	0.26	10.84
1994	0.00	0.03	1.51	1.66	3.10	1.15	0.44	0.88	0.20	0.35	9.32
1995	0.00	0.08	0.45	2.99	1.82	1.25	0.45	0.11	0.16	0.14	7.45
1996	0.00	0.22	0.49	4.20	10.44	3.45	2.49	1.07	0.26	0.48	23.09
1997	0.00	0.07	0.90	1.37	3.19	3.04	0.52	0.12	0.08	0.10	9.40
1998	0.00	0.01	1.40	2.00	0.78	0.76	0.57	0.13	0.07	0.05	5.78
1999	0.00	0.01	0.38	3.12	2.63	1.08	0.76	0.46	0.02	0.11	8.57
2000	0.00	0.00	1.02	3.12	11.96	5.19	2.48	1.23	0.76	0.13	25.89
2001	0.00	0.01	0.09	1.93	1.25	3.35	1.55	0.80	0.54	0.70	10.23
2002	0.00	0.00	0.28	1.15	5.05	1.67	3.09	1.10	0.45	0.35	13.15
2003	0.00	0.00	0.02	0.48	1.23	2.09	0.47	0.53	0.17	0.03	5.00
2004	0.00	1.03	0.10	0.59	0.92	1.02	0.85	0.14	0.26	0.08	4.98
2005	0.00	0.06	2.47	3.37	17.21	4.25	1.97	1.79	0.15	0.24	31.50
2006	0.00	0.00	0.10	3.61	1.62	4.28	1.82	0.52	0.52	0.34	12.82
2007	0.00	0.04	0.31	1.32	6.27	0.91	1.57	0.29	0.20	0.14	11.05
2008	0.00	0.03	0.35	2.47	1.82	7.17	0.47	0.94	0.10	0.06	13.41

Table 9. Indices of abundance (numbers/standard tow) of eastern Georges Bank cod from the NMFS spring survey.

	Age Group										
Year	0	1	2	3	4	5	6	7	8	9+	Total
1970	0.00	0.68	2.14	0.58	1.17	0.14	0.51	0.09	0.00	0.27	5.59
1971	0.00	0.33	1.29	0.91	0.21	0.59	0.22	0.46	0.41	0.29	4.72
1972	0.10	2.85	3.35	4.47	0.71	0.21	0.25	0.11	0.16	0.21	12.41
1973	0.00	1.20	68.33	9.87	11.02	1.02	0.84	0.75	0.00	0.88	93.92
1974	0.00	0.83	10.60	7.27	1.37	3.61	0.65	0.16	0.48	0.26	25.24
1975	0.00	0.00	0.84	5.52	7.84	0.80	1.73	0.14	0.00	0.22	17.11
1976	0.16	3.33	2.14	1.19	0.85	1.46	0.00	0.32	0.07	0.09	9.62
1977	0.00	0.00	4.25	1.33	0.64	0.55	0.60	0.04	0.06	0.00	7.48
1978	0.67	0.34	0.00	5.10	1.11	1.65	0.28	1.42	0.11	0.15	10.82
1979	0.13	0.61	2.40	0.22	2.58	0.98	0.32	0.16	0.24	0.00	7.64
1980	0.00	0.02	4.33	4.17	0.32	3.81	0.79	0.15	0.09	0.15	13.84
1981	0.53	3.64	2.44	3.74	2.04	0.08	0.84	0.37	0.11	0.00	13.78
1982	0.08	0.82	11.98	24.56	22.85	16.97	0.00	5.57	1.79	0.22	84.83
1983	0.00	0.70	3.64	6.82	1.41	1.10	0.57	0.19	0.18	0.19	14.79
1984	0.00	0.20	0.22	0.66	0.93	0.18	0.35	0.14	0.04	0.20	2.92
1985	0.10	0.07	3.67	1.14	1.91	2.74	0.59	0.39	0.38	0.46	11.46
1986	0.17	1.12	0.61	2.04	0.54	0.77	0.97	0.04	0.20	0.26	6.71
1987	0.00	0.00	2.15	0.45	1.02	0.00	0.27	0.27	0.05	0.10	4.32
1988	0.25	0.58	0.44	5.04	0.49	0.83	0.09	0.01	0.12	0.02	7.87
1989	0.00	0.31	2.23	0.61	3.04	0.42	0.71	0.18	0.02	0.20	7.73
1990	0.04	0.08	0.67	3.14	1.09	1.18	0.28	0.31	0.03	0.04	6.89
1991	0.39	1.31	1.12	0.93	1.63	0.83	0.69	0.08	0.03	0.14	7.14
1992	0.00	0.15	1.20	0.63	0.19	0.47	0.27	0.29	0.05	0.09	3.34
1993	0.00	0.00	0.83	2.32	0.47	0.08	0.33	0.08	0.08	0.10	4.30
1994	0.07	0.10	0.37	0.29	0.36	0.09	0.02	0.06	0.00	0.01	1.38
1995	0.69	0.13	0.53	1.67	0.89	1.68	0.35	0.46	0.00	0.12	6.52
1996	0.00	0.25	0.54	1.79	2.42	0.22	0.17	0.05	0.00	0.00	5.44
1997	0.49	0.10	0.39	0.09	0.72	0.94	0.10	0.23	0.10	0.00	3.15
1998	0.10	0.00	2.00	3.82	1.91	1.89	1.17	0.06	0.06	0.00	11.01
1999	0.04	0.04	0.26	1.21	1.12	0.67	0.31	0.19	0.06	0.01	3.92
2000	0.07	0.00	0.55	1.16	2.43	0.89	0.25	0.09	0.04	0.00	5.47
2001	0.00	0.00	0.12	1.60	0.17	0.63	0.20	0.00	0.02	0.02	2.76
2002	0.07	0.00	0.23	0.90	2.08	0.34	0.41	0.12	0.00	0.00	4.15
2003	0.00	0.00	0.22	0.52	1.47	2.08	0.24	0.14	0.02	0.00	4.69
2004	0.00	0.99	0.02	1.51	3.77	3.80	2.44	0.43	0.69	0.05	13.70
2005	0.07	0.03	0.62	0.13	1.35	0.52	0.34	0.24	0.06	0.00	3.35
2006	0.00	0.07	0.13	1.72	0.74	1.82	0.61	0.27	0.14	0.00	5.50
2007	0.00	0.00	0.67	0.56	4.07	0.43	0.53	0.08	0.05	0.00	6.39
2008	0.08	0.07	0.20	1.22	0.67	2.50	0.09	0.12	0.00	0.00	4.94

Table 10. Indices of abundance (numbers/standard tow) of eastern Georges Bank cod from the NMFS autumn survey.

	Age Group										
Year	0	1	2	3	4	5	6	7	8	9+	Total
1970	0.63	2.55	1.51	0.38	0.74	0.02	0.00	0.00	0.01	0.05	5.88
1971	0.37	2.07	1.62	0.33	0.42	0.24	0.26	0.03	0.00	0.00	5.32
1972	2.00	5.95	1.11	1.20	0.04	0.07	0.00	0.00	0.00	0.00	10.38
1973	0.09	4.59	5.55	1.88	1.84	0.17	0.00	0.05	0.12	0.00	14.29
1974	0.15	0.38	0.77	1.20	0.10	0.06	0.03	0.00	0.00	0.00	2.68
1975	0.75	1.19	0.32	0.75	1.38	0.05	0.08	0.00	0.00	0.00	4.51
1976	0.00	15.88	0.70	0.28	0.00	0.18	0.00	0.09	0.00	0.00	17.12
1977	0.09	0.00	6.27	1.29	0.33	0.28	0.32	0.01	0.00	0.00	8.59
1978	0.20	2.74	0.10	5.46	0.75	0.10	0.11	0.14	0.00	0.00	9.62
1979	0.33	3.07	3.06	0.21	2.75	0.44	0.09	0.04	0.02	0.03	10.02
1980	0.58	1.41	0.74	1.17	0.04	0.33	0.03	0.03	0.04	0.00	4.36
1981	0.65	4.24	2.18	1.68	0.49	0.03	0.05	0.00	0.00	0.10	9.42
1982	0.00	0.99	1.30	0.10	0.11	0.00	0.00	0.05	0.00	0.00	2.54
1983	1.67	0.12	0.33	1.25	0.04	0.00	0.00	0.00	0.04	0.00	3.46
1984	0.05	3.26	0.22	1.19	1.89	0.05	0.07	0.00	0.00	0.02	6.74
1985	2.25	0.38	1.79	0.29	0.03	0.01	0.02	0.00	0.00	0.01	4.77
1986	0.21	5.44	0.10	0.36	0.00	0.00	0.01	0.00	0.00	0.00	6.13
1987	0.28	0.23	1.52	0.22	0.18	0.00	0.00	0.00	0.00	0.01	2.45
1988	0.17	1.01	0.32	2.13	0.29	0.37	0.00	0.05	0.07	0.02	4.44
1989	0.57	1.03	2.41	0.40	1.09	0.14	0.04	0.00	0.00	0.00	5.69
1990	0.36	0.73	0.88	1.42	0.21	0.36	0.05	0.00	0.03	0.00	4.03
1991	0.00	0.35	0.14	0.16	0.02	0.05	0.00	0.00	0.00	0.00	0.72
1992	0.00	0.37	1.31	0.28	0.00	0.07	0.02	0.00	0.00	0.00	2.05
1993	0.00	0.15	0.19	0.29	0.03	0.00	0.00	0.00	0.00	0.00	0.65
1994	0.02	0.15	0.53	0.41	0.27	0.02	0.05	0.00	0.00	0.00	1.44
1995	0.40	0.05	0.23	0.56	0.09	0.05	0.01	0.00	0.00	0.00	1.41
1996	0.02	0.56	0.15	0.56	0.41	0.10	0.05	0.00	0.00	0.00	1.85
1997	0.00	0.27	0.69	0.27	0.15	0.20	0.05	0.00	0.00	0.00	1.64
1998	0.00	0.23	1.16	1.06	0.17	0.22	0.00	0.00	0.06	0.00	2.90
1999	0.00	0.03	0.03	0.45	0.22	0.06	0.00	0.00	0.00	0.00	0.78
2000	0.05	0.10	0.37	0.12	0.16	0.08	0.00	0.00	0.00	0.00	0.89
2001	0.04	0.13	0.19	0.46	0.07	0.14	0.02	0.02	0.00	0.00	1.08
2002	0.22	0.20	1.14	1.28	4.51	0.31	0.38	0.03	0.00	0.00	8.07
2003	0.14	0.00	0.04	0.18	0.13	0.03	0.00	0.01	0.00	0.00	0.53
2004	0.20	0.76	0.12	1.52	0.70	0.98	0.79	0.19	0.05	0.05	5.36
2005	0.04	0.05	0.92	0.21	0.45	0.08	0.00	0.02	0.00	0.00	1.76
2006	0.00	0.28	0.24	1.02	0.07	0.51	0.03	0.03	0.03	0.03	2.23
2007	0.08	0.04	0.25	0.01	0.15	0.00	0.01	0.00	0.00	0.00	0.55

Table 11. Average weight at age (kg) for eastern Georges Bank cod from the DFO survey.

	Age Group										
Year	1	2	3	4	5	6	7	8	9	10	11
1978[1]	0.13	0.83	1.74	2.79	4.29	6.16	7.43	8.47	11.10	13.04	16.81
1979[1]	0.13	0.83	1.74	2.79	4.29	6.16	7.43	8.47	11.10	13.04	16.81
1980[1]	0.13	0.83	1.74	2.79	4.29	6.16	7.43	8.47	11.10	13.04	16.81
1981[1]	0.13	0.83	1.74	2.79	4.29	6.16	7.43	8.47	11.10	13.04	16.81
1982[1]	0.13	0.83	1.74	2.79	4.29	6.16	7.43	8.47	11.10	13.04	16.81
1983[1]	0.13	0.83	1.74	2.79	4.29	6.16	7.43	8.47	11.10	13.04	16.81
1984[1]	0.13	0.83	1.74	2.79	4.29	6.16	7.43	8.47	11.10	13.04	16.81
1985[1]	0.13	0.83	1.74	2.79	4.29	6.16	7.43	8.47	11.10	13.04	16.81
1986	0.12	0.81	1.70	2.78	4.20	6.22	7.31	9.31	13.86	14.15	16.81
1987	0.15	0.85	1.70	2.69	5.67	7.49	7.48	6.66	10.10	7.00	16.81
1988	0.15	0.93	1.79	3.02	4.17	6.27	8.44	8.72	12.33	14.16	11.40
1989	0.14	0.83	1.70	2.76	4.31	6.43	7.62	7.81	11.32	10.30	14.72
1990	0.21	0.79	1.84	2.90	4.36	6.00	8.59	9.52	13.49	14.41	17.97
1991	0.09	0.90	1.95	3.17	4.24	4.90	7.54	10.06	9.97	15.50	13.49
1992	0.12	0.82	1.94	2.88	4.19	5.89	6.58	8.59	9.91	11.95[2]	24.60
1993	0.07	0.95	1.84	2.92	4.44	5.81	6.75	7.40	9.28	8.41	21.63[2]
1994	0.06	0.66	1.41	2.65	3.99	7.61	7.70	8.66	8.87	18.41	21.63[2]
1995	0.17	0.78	1.54	2.11	3.29	5.00	6.33	7.92	11.89	14.99	18.65
1996	0.05	0.76	1.56	2.56	4.00	6.11	5.55	12.03	11.92	13.79	19.75
1997	0.11	0.72	1.68	2.17	3.19	6.39	6.74	11.29	10.17	16.59	17.67
1998	0.08	0.61	1.29	2.22	3.09	4.64	5.77	8.40	8.21	8.25	15.59
1999	0.16	1.03	1.33	2.18	2.98	4.65	6.93	11.00	8.45	16.92	14.83
2000	0.08[2]	0.91	1.59	2.30	3.12	4.60	6.51	8.28	11.52	13.88	14.14
2001	0.01	0.68	1.40	2.44	3.59	5.14	6.91	7.47	10.25	9.85	11.76
2002	0.01	0.42	1.17	2.31	3.59	4.41	5.95	8.44	10.00	11.84	15.76
2003	0.01	0.18	1.03	1.79	3.09	3.48	5.24	6.81	7.66	10.44[2]	14.33[2]
2004	0.02	0.23	1.45	2.34	3.67	4.28	4.59	6.77	10.54	9.03	14.33[2]
2005	0.01	0.60	1.18	1.70	2.90	3.37	3.96	6.90	6.45	4.61	12.90
2006	0.03[2]	0.31	1.14	1.45	2.55	3.19	4.40	4.61	5.73	6.90	6.12
2007	0.05	0.55	1.05	1.86	2.59	4.27	6.13	6.98	7.98	7.40[2]	6.02
2008	0.04	0.60	1.47	2.11	2.55	3.65	4.21	7.93	10.05	7.89	6.02[2]
Min.	0.01	0.18	1.03	1.45	2.55	3.19	3.96	4.61	5.73	4.61	6.02
Max.	0.21	1.03	1.95	3.17	5.67	7.61	8.59	12.03	13.49	18.41	24.60
3 yr Avg.[3]	0.04	0.49	1.22	1.81	2.56	3.71	4.91	6.51	7.92	7.40	6.05
5 yr Avg.[4]	0.03	0.46	1.26	1.89	2.86	3.75	4.66	6.64	8.15	7.17	9.08

[1]average of 1986 to 1995 observed values
[2]average of adjacent years
[3]3 year average, 2006-2008
[4]5 year average, 2004-2008

Table 12. Statistical properties of estimates for population abundance (numbers in thousands) and survey calibration constants from the "Around the Corner" benchmark model formulation for eastern Georges Bank cod obtained from a bootstrap with 1000 replications.

Parameter	Estimate	Standard Error	Relative Error	Bias	Relative Bias
N[1999 11]	32	20	0.619	3	0.108
N[2000 11]	43	25	0.580	4	0.090
N[2001 11]	76	40	0.527	7	0.088
N[2002 11]	42	24	0.579	3	0.076
N[2003 11]	87	48	0.550	9	0.107
N[2004 11]	88	39	0.444	5	0.055
N[2005 11]	106	43	0.406	5	0.044
N[2006 11]	123	53	0.429	6	0.051
N[2007 2]	188	82	0.437	8	0.044
N[2007 3]	822	575	0.699	141	0.171
N[2007 4]	1785	669	0.374	130	0.073
N[2007 5]	435	141	0.325	26	0.061
N[2007 6]	2661	812	0.305	147	0.055
N[2007 7]	233	78	0.334	15	0.066
N[2007 8]	466	153	0.328	14	0.031
N[2007 9]	312	95	0.304	10	0.034
N[2007 10]	243	79	0.326	10	0.041
N[2007 11]	212	88	0.416	10	0.049
DFO 2	0.264	0.050	0.189	0.000	0.002
DFO 3	1.120	0.206	0.184	0.014	0.013
DFO 4	1.892	0.383	0.203	0.033	0.018
DFO 5	2.450	0.484	0.197	0.039	0.016
DFO 6	2.386	0.478	0.200	0.038	0.016
DFO 7	2.123	0.432	0.204	0.048	0.022
NMFS spring Y41 1	0.033	0.016	0.488	0.003	0.077
NMFS spring Y41 2	0.396	0.259	0.656	0.055	0.138
NMFS spring Y41 3	0.470	0.235	0.500	0.042	0.089
NMFS spring Y41 4	0.462	0.227	0.491	0.030	0.065
NMFS spring Y41 5	0.737	0.354	0.481	0.064	0.086
NMFS spring Y41 6	0.831	0.410	0.494	0.061	0.074
NMFS spring Y41 7	1.356	0.697	0.514	0.129	0.095
NMFS spring Y41 8	1.422	0.704	0.495	0.142	0.100
NMFS spring Y36 1	0.044	0.009	0.207	0.001	0.020
NMFS spring Y36 2	0.190	0.033	0.174	0.002	0.012
NMFS spring Y36 3	0.515	0.091	0.176	0.006	0.011
NMFS spring Y36 4	0.862	0.155	0.179	0.013	0.015
NMFS spring Y36 5	1.007	0.191	0.190	0.011	0.011
NMFS spring Y36 6	0.823	0.151	0.183	0.013	0.015
NMFS spring Y36 7	0.729	0.141	0.193	0.018	0.024
NMFS spring Y36 8	0.614	0.130	0.211	0.018	0.029
NMFS autumn 1	0.097	0.017	0.171	0.001	0.006
NMFS autumn 2	0.139	0.023	0.165	0.001	0.004
NMFS autumn 3	0.241	0.039	0.161	0.002	0.010
NMFS autumn 4	0.174	0.032	0.181	0.002	0.009
NMFS autumn 5	0.178	0.035	0.195	0.004	0.024

Table 13. Beginning of year population abundance (numbers in thousands) for eastern Georges Bank cod using the benchmark model formulation.

Year	Age Group											
	1	2	3	4	5	6	7	8	9	10	11	1+
1978	11131	2210	10563	3506	991	307	279	56	26	9	0	29078
1979	9504	9112	1700	5432	1905	536	152	154	27	11	4	28538
1980	9231	7772	6714	1028	2830	1062	303	105	85	19	6	29154
1981	17355	7557	5467	4143	601	1490	558	149	68	39	10	37438
1982	6287	14192	5638	3167	2260	352	682	304	64	23	16	32984
1983	4581	5142	9196	3097	1312	895	119	250	108	19	8	24727
1984	13532	3715	3022	4462	1217	655	478	70	140	54	10	27355
1985	4532	11070	2797	1652	2438	536	276	185	29	50	20	23586
1986	21113	3699	6543	1194	785	1150	238	139	62	11	17	34953
1987	7033	17261	2733	3381	515	368	581	142	79	28	6	32126
1988	13651	5745	10835	1461	1782	293	193	325	83	43	16	34429
1989	4094	11168	4418	5624	624	697	112	68	140	32	18	26995
1990	5744	3308	8404	3016	2965	339	293	42	33	69	16	24229
1991	9196	4695	2061	4002	1603	1355	173	130	26	15	36	23292
1992	2732	7499	3192	969	1542	466	407	59	56	5	6	16933
1993	3947	2149	3937	1493	407	456	159	126	26	22	2	12726
1994	2748	3225	1347	1452	499	141	80	32	21	1	3	9549
1995	2069	2247	2471	665	518	188	79	13	4	0	0	8255
1996	3214	1692	1789	1811	437	344	141	61	8	2	0	9499
1997	4815	2628	1348	1250	1123	287	237	105	47	5	1	11845
1998	1769	3940	2028	911	654	507	134	144	69	35	4	10195
1999	4424	1448	3132	1318	568	355	265	86	104	52	28	11780
2000	2599	3619	1129	2078	752	366	235	170	60	83	39	11128
2001	2156	2126	2909	820	1399	499	268	174	128	47	68	10594
2002	2863	1764	1639	1957	490	808	320	193	127	100	38	10299
2003	940	2341	1429	1224	1263	313	531	239	151	101	81	8611
2004	7094	768	1888	1010	753	681	191	361	181	121	81	13128
2005	920	5806	616	1426	690	496	441	127	275	144	98	11040
2006	2585	752	4673	454	994	514	378	325	94	221	117	11107
2007	882	2111	598	3600	301	644	377	293	251	75	179	9311
2008	2368	720	1660	414	2582	219	450	299	233	200	61	9205

Table 14. Annual fishing mortality rate for eastern Georges Bank cod using the benchmark model formulation.

Year	Age Group										
	1	2	3	4	5	6	7	8	9	10	4-6
1978	0.000	0.062	0.465	0.410	0.415	0.499	0.395	0.529	0.648	0.567	0.417
1979	0.001	0.105	0.304	0.452	0.384	0.371	0.176	0.394	0.167	0.361	0.430
1980	0.000	0.152	0.283	0.336	0.442	0.444	0.506	0.238	0.566	0.385	0.420
1981	0.001	0.093	0.346	0.406	0.336	0.581	0.408	0.653	0.880	0.723	0.441
1982	0.001	0.234	0.399	0.682	0.726	0.883	0.805	0.832	1.005	0.862	0.711
1983	0.010	0.332	0.523	0.734	0.494	0.427	0.337	0.375	0.501	0.413	0.623
1984	0.001	0.084	0.404	0.404	0.619	0.665	0.749	0.671	0.830	0.777	0.473
1985	0.003	0.326	0.651	0.544	0.551	0.613	0.482	0.892	0.770	0.875	0.556
1986	0.001	0.103	0.460	0.640	0.556	0.484	0.314	0.370	0.609	0.443	0.562
1987	0.002	0.266	0.426	0.440	0.366	0.446	0.379	0.336	0.397	0.358	0.432
1988	0.001	0.063	0.456	0.651	0.738	0.758	0.844	0.646	0.756	0.668	0.704
1989	0.013	0.084	0.182	0.440	0.411	0.669	0.775	0.510	0.509	0.509	0.460
1990	0.002	0.272	0.542	0.432	0.583	0.471	0.610	0.301	0.631	0.447	0.505
1991	0.004	0.186	0.552	0.754	1.036	1.003	0.878	0.635	1.379	0.758	0.867
1992	0.040	0.444	0.559	0.657	1.017	0.875	0.970	0.621	0.728	0.673	0.878
1993	0.002	0.266	0.793	0.886	0.812	1.546	1.389	1.595	2.909	1.819	1.001
1994	0.001	0.066	0.500	0.810	0.732	0.318	1.564	1.912	6.103	3.558	0.759
1995	0.001	0.028	0.110	0.216	0.197	0.078	0.045	0.265	0.514	0.325	0.190
1996	0.001	0.027	0.157	0.274	0.214	0.159	0.083	0.035	0.251	0.058	0.249
1997	0.001	0.058	0.186	0.437	0.576	0.517	0.256	0.164	0.049	0.149	0.504
1998	0.000	0.029	0.227	0.261	0.389	0.408	0.204	0.085	0.031	0.006	0.337
1999	0.001	0.048	0.207	0.350	0.223	0.192	0.198	0.125	0.001	0.015	0.293
2000	0.001	0.018	0.118	0.191	0.198	0.099	0.086	0.055	0.020	-0.008	0.182
2001	0.001	0.059	0.193	0.306	0.333	0.223	0.112	0.095	0.006	0.004	0.305
2002	0.001	0.010	0.089	0.232	0.237	0.204	0.081	0.037	0.026	-0.018	0.226
2003	0.002	0.015	0.142	0.274	0.397	0.272	0.163	0.064	0.019	0.011	0.329
2004	0.000	0.019	0.078	0.173	0.204	0.211	0.182	0.058	0.022	0.006	0.193
2005	0.002	0.016	0.101	0.155	0.089	0.066	0.090	0.080	0.017	0.008	0.120
2006	0.002	0.027	0.058	0.197	0.220	0.101	0.049	0.049	0.022	0.005	0.183
2007	0.002	0.036	0.154	0.123	0.107	0.145	0.030	0.025	0.023	0.005	0.125

Table 15. Beginning of year population biomass (thousands of mt) for eastern Georges Bank cod using the benchmark model formulation.

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1978	1376	1836	18395	9770	4247	1889	2073	473	294	111	2	40468	37255
1979	1175	7570	2961	15138	8165	3302	1133	1303	300	139	71	41257	32512
1980	1141	6457	11692	2864	12131	6546	2250	886	943	229	109	45248	37649
1981	2146	6278	9521	11545	2578	9179	4148	1266	750	484	175	48071	39646
1982	777	11791	9818	8827	9687	2168	5069	2571	708	281	264	51961	39393
1983	566	4272	16016	8630	5622	5515	885	2113	1201	234	133	45189	40350
1984	1673	3086	5262	12436	5214	4038	3555	589	1559	659	174	38247	33487
1985	560	9197	4871	4603	10452	3305	2050	1567	323	615	340	37884	28126
1986	2555	2982	11124	3323	3298	7151	1739	1298	861	156	288	34773	29236
1987	1055	14586	4649	9079	2924	2758	4342	947	797	194	97	41427	25787
1988	2078	5346	19343	4414	7431	1835	1629	2839	1026	615	181	46736	39312
1989	582	9290	7532	15515	2688	4486	855	531	1581	330	268	43659	33786
1990	1233	2605	15488	8744	12936	2034	2513	403	451	991	283	47680	43843
1991	807	4210	4023	12675	6802	6633	1306	1309	256	226	486	38732	33715
1992	336	6137	6178	2789	6461	2745	2677	507	559	0	137	28527	22054
1993	277	2051	7227	4355	1809	2653	1073	934	241	188	48	20855	18527
1994	176	2128	1903	3848	1988	1073	613	281	186	21	64	12280	9976
1995	349	1764	3817	1404	1705	942	499	106	45	1	0	10632	8519
1996	146	1278	2787	4639	1744	2099	784	731	99	24	0	14330	12905
1997	537	1894	2260	2713	3585	1832	1594	1185	481	85	23	16190	13759
1998	138	2412	2616	2019	2018	2353	776	1205	569	292	55	14453	11903
1999	690	1489	4179	2872	1692	1647	1837	951	879	888	415	17541	15361
2000	0	3276	1797	4778	2346	1683	1528	1408	689	1156	549	19211	15936
2001	22	1455	4065	2003	5020	2563	1853	1299	1315	467	799	20862	19385
2002	0	747	1925	4513	1760	3566	1903	1629	1270	1185	604	19103	18356
2003	0	421	1475	2187	3901	1090	2779	1624	1160	0	1154	15791	15370
2004	111	175	2746	2359	2769	2911	876	2442	1906	1094	1164	18553	18267
2005	10	3486	726	2424	2002	1673	1749	873	1775	665	1270	16653	13157
2006	83	236	5348	658	2536	1639	1663	1499	537	1523	716	16438	16118
2007	47	1157	626	6706	779	2753	2313	2047	2004	552	1079	20064	18860
2008	101	430	2446	873	6595	801	1895	2370	2345	1575	365	19797	19266

Table 16. Projection inputs for eastern Georges Bank cod using the benchmark model formulation.

	Age Group										
	1	2	3	4	5	6	7	8	9	10	11
Natural Mortality											
2007-2008	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Fishery Partial Recruitment											
2007-2008	0.01	0.10	0.70	1.00	1.00	1.00	0.60	0.40	0.10	0.05	0.05
Fishery Weight at Age											
2007-2008	0.28	0.90	1.61	2.40	3.31	4.24	5.76	6.47	7.24	8.48	11.64
Population Beginning of Year Weight at Age											
2008-2009	0.04	0.49	1.22	1.81	2.56	3.71	4.91	6.51	7.92	7.40	8.35

Table 17. Deterministic projection results for eastern Georges Bank cod, benchmark model formulation.

	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
Projected Population Numbers													
2009	2368	1935	579	1196	282	1762	150	330	228	188	162		
2010	2368	1935	1556	418	818	193	1205	110	252	183	152		
Fishing Mortality													
2008	0.002	0.018	0.127	0.182	0.182	0.182	0.109	0.073	0.018	0.009	0.009		
2009	0.002	0.018	0.126	0.18	0.18	0.18	0.108	0.072	0.018	0.009	0.009		
Projected Population Biomass													
2009	95	948	706	2166	723	6538	735	2150	1802	1388	1352	18604	17561
2010	95	948	1899	756	2095	716	5918	716	1993	1354	1271	17760	16717
Projected Catch Numbers													
2008	4	12	180	63	390	33	42	19	4	2	0		
2009	4	31	62	179	42	264	14	21	4	2	1		
Projected Catch Biomass													
2008	1	11	291	150	1293	141	243	123	28	14	6	2300	
2009	1	28	100	429	140	1120	80	135	27	13	15	2089	

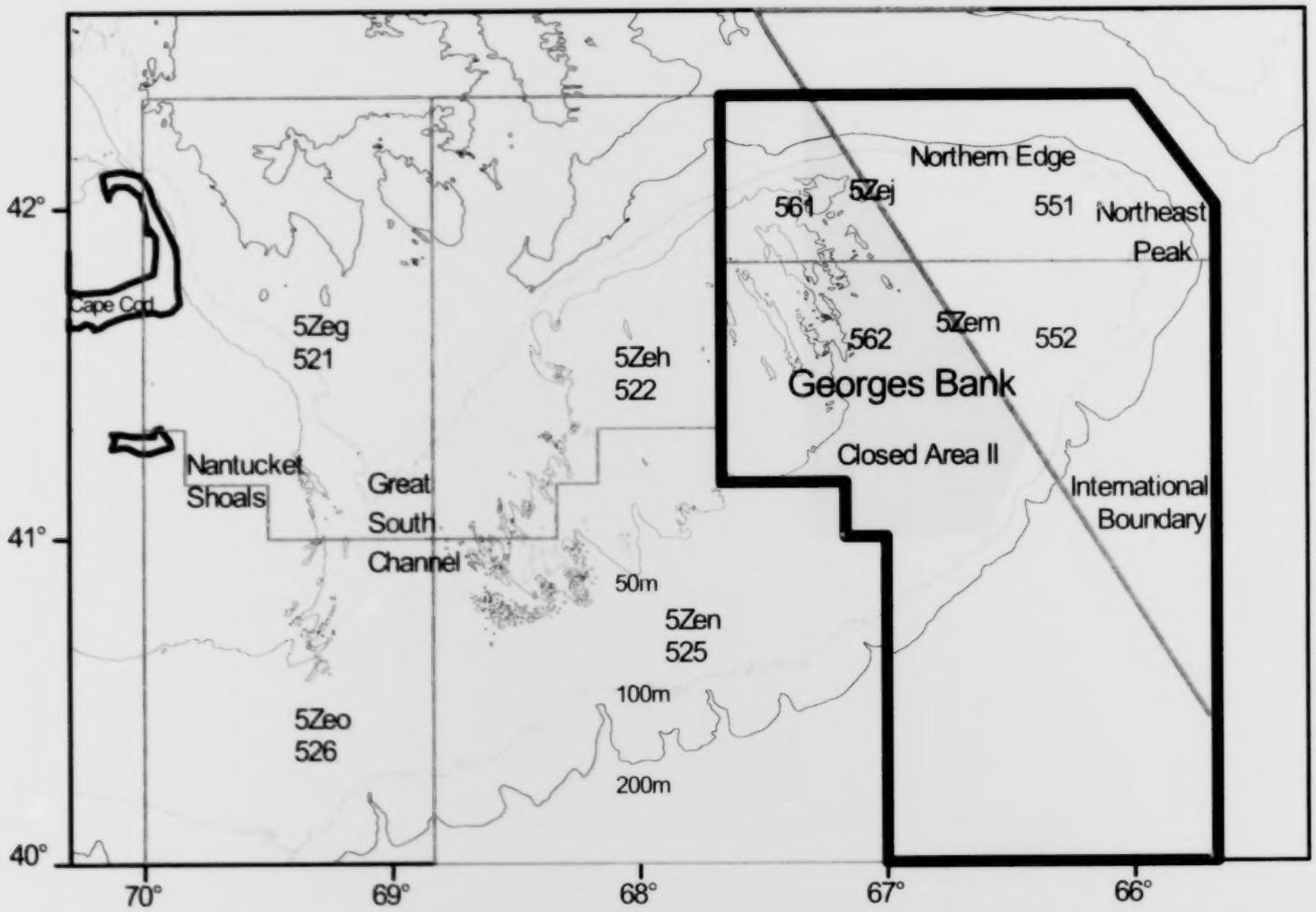

Figure 1. Fisheries statistical unit areas in NAFO Subdivision 5Ze. The eastern Georges Bank management unit is outlined by a heavy black line.

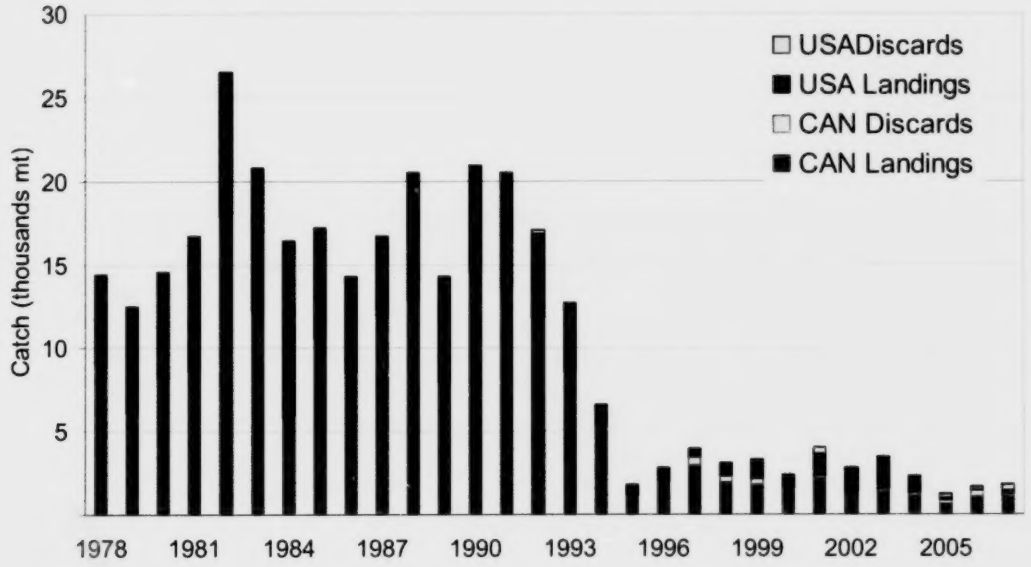

Figure 2. Catches (mt) of cod from eastern Georges Bank during 1978-2007.

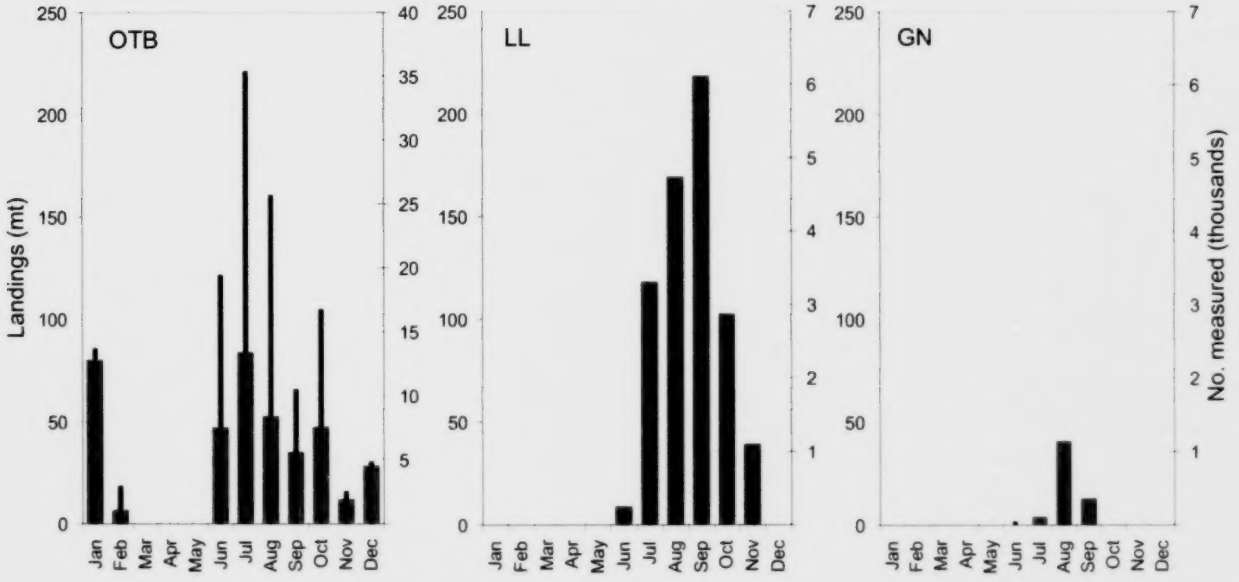

Figure 3. Landings (wide bars) and sampling (narrow dark bars) of cod by gear and month from the 2007 Canadian groundfish fishery on eastern Georges Bank.

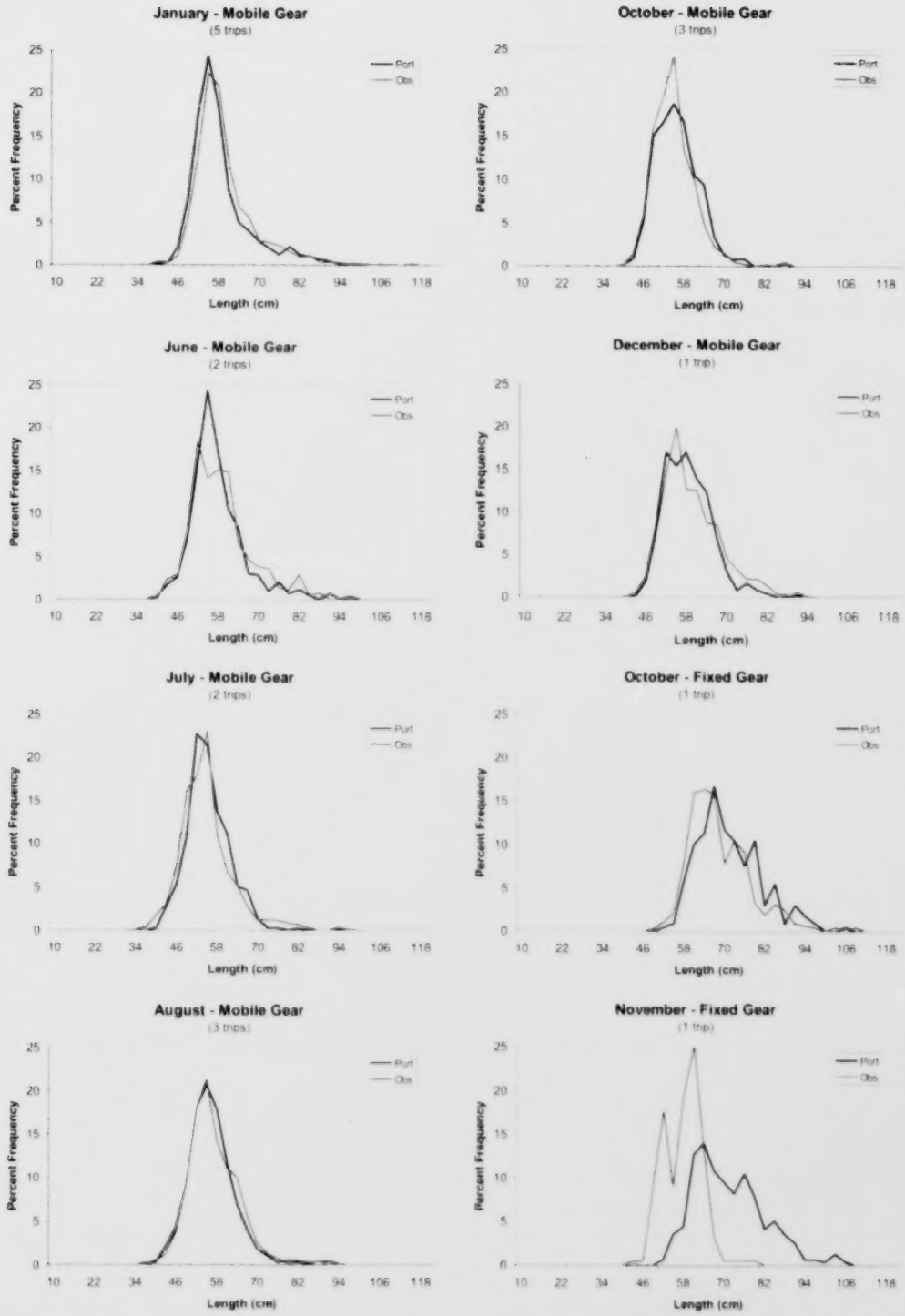

Figure 4. Comparison of cod length composition from port and sea sampling for the 2007 Canadian fishery on eastern Georges Bank.

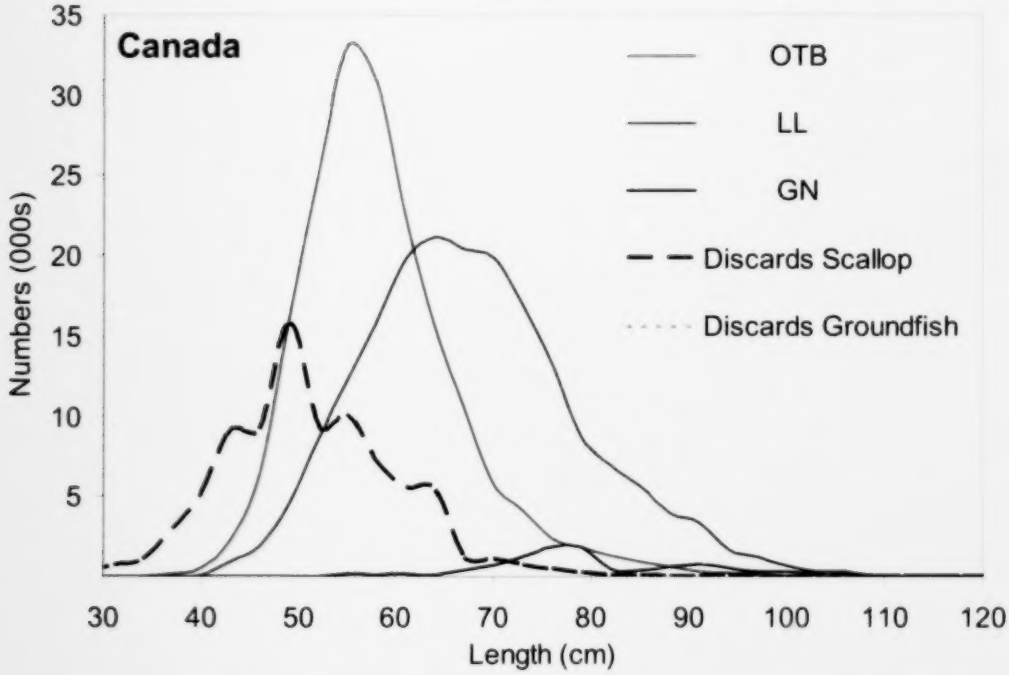

Figure 5. Cod catches at length by gear from the 2007 Canadian fisheries on eastern Georges Bank.

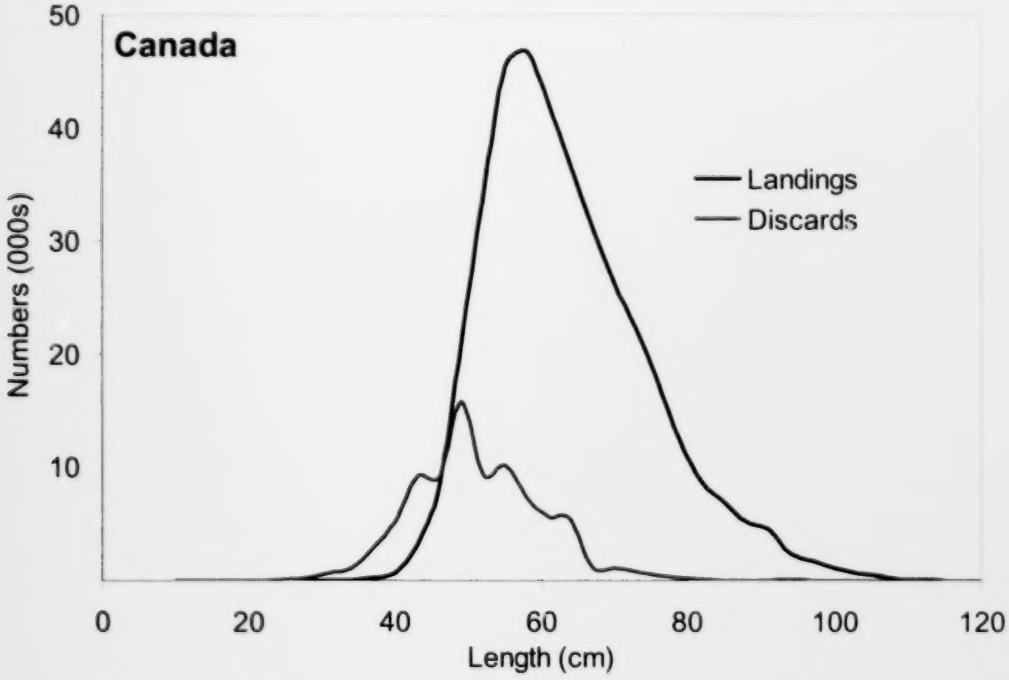

Figure 6. Cod landings and discards at length from the 2007 Canadian fisheries on eastern Georges Bank.

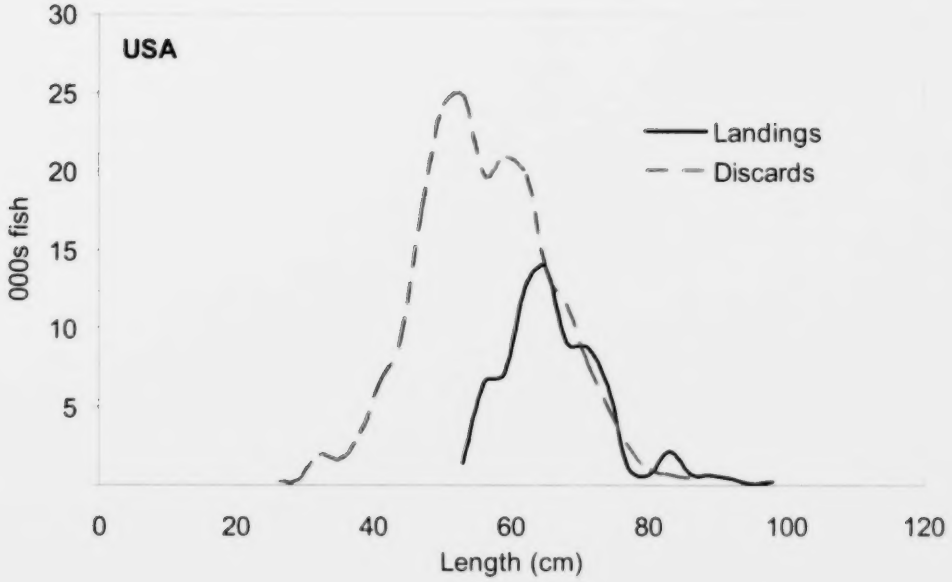

Figure 7. Cod landings and discards at length from the 2007 USA fisheries on eastern Georges Bank.

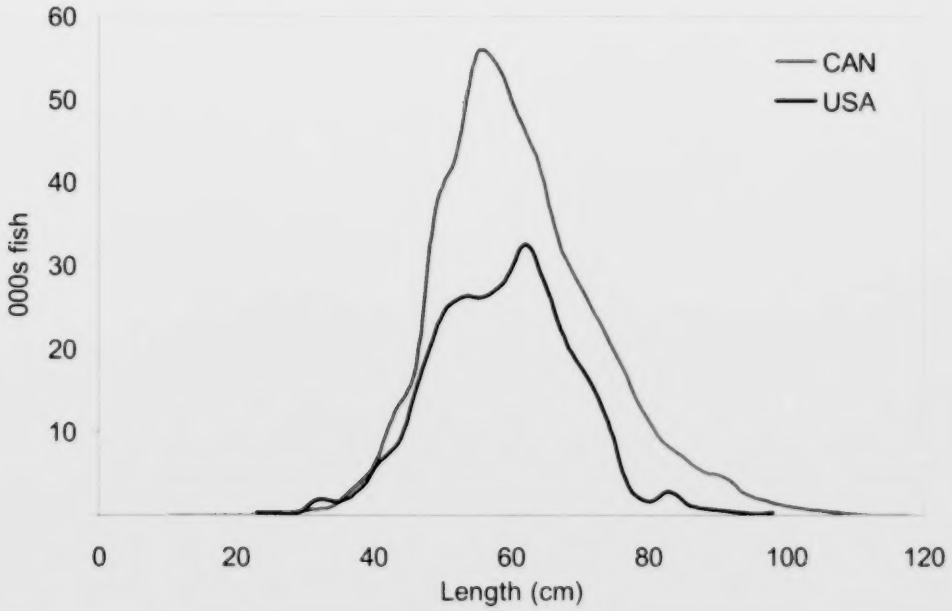

Figure 8. Catch composition from the 2007 Canadian and USA fisheries on eastern Georges Bank.

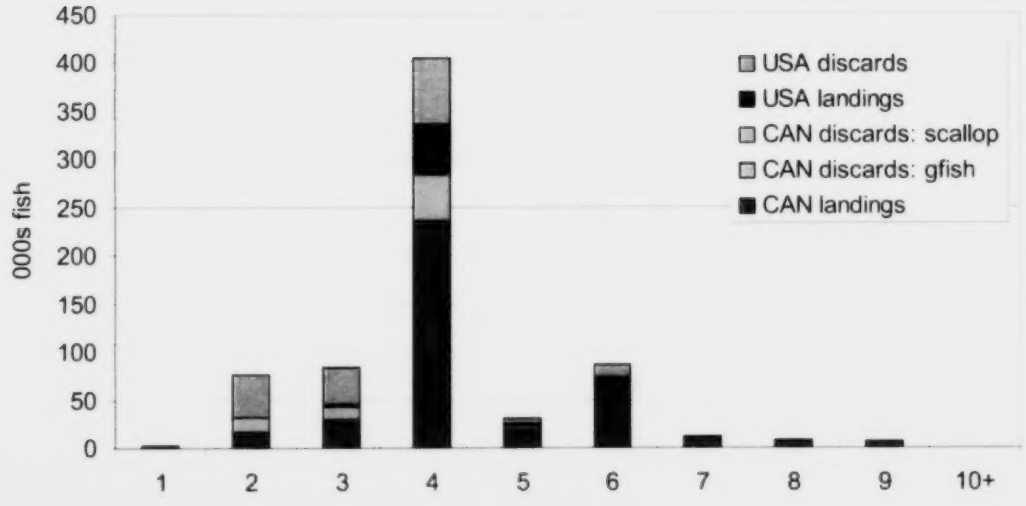

Figure 9. Catch at age for landings and discards of cod from the 2007 fisheries on eastern Georges Bank.

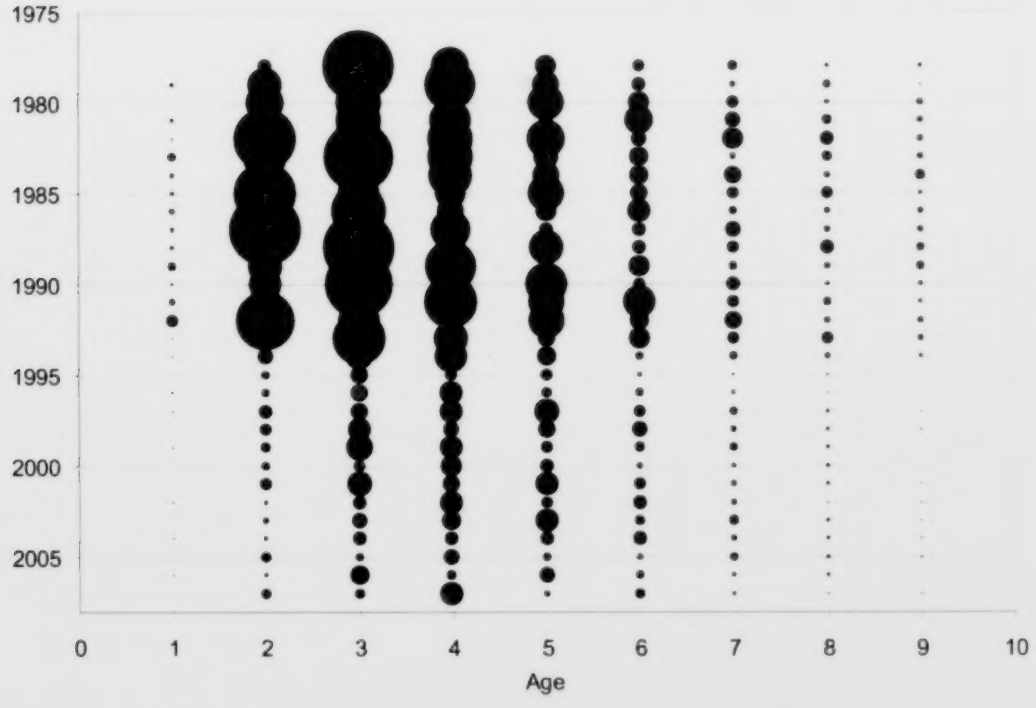

Figure 10. Total catch at age (numbers) of cod from eastern Georges Bank for 1978 to 2007. The bubble area is proportional to magnitude. The blue circles are the 2003 year class.

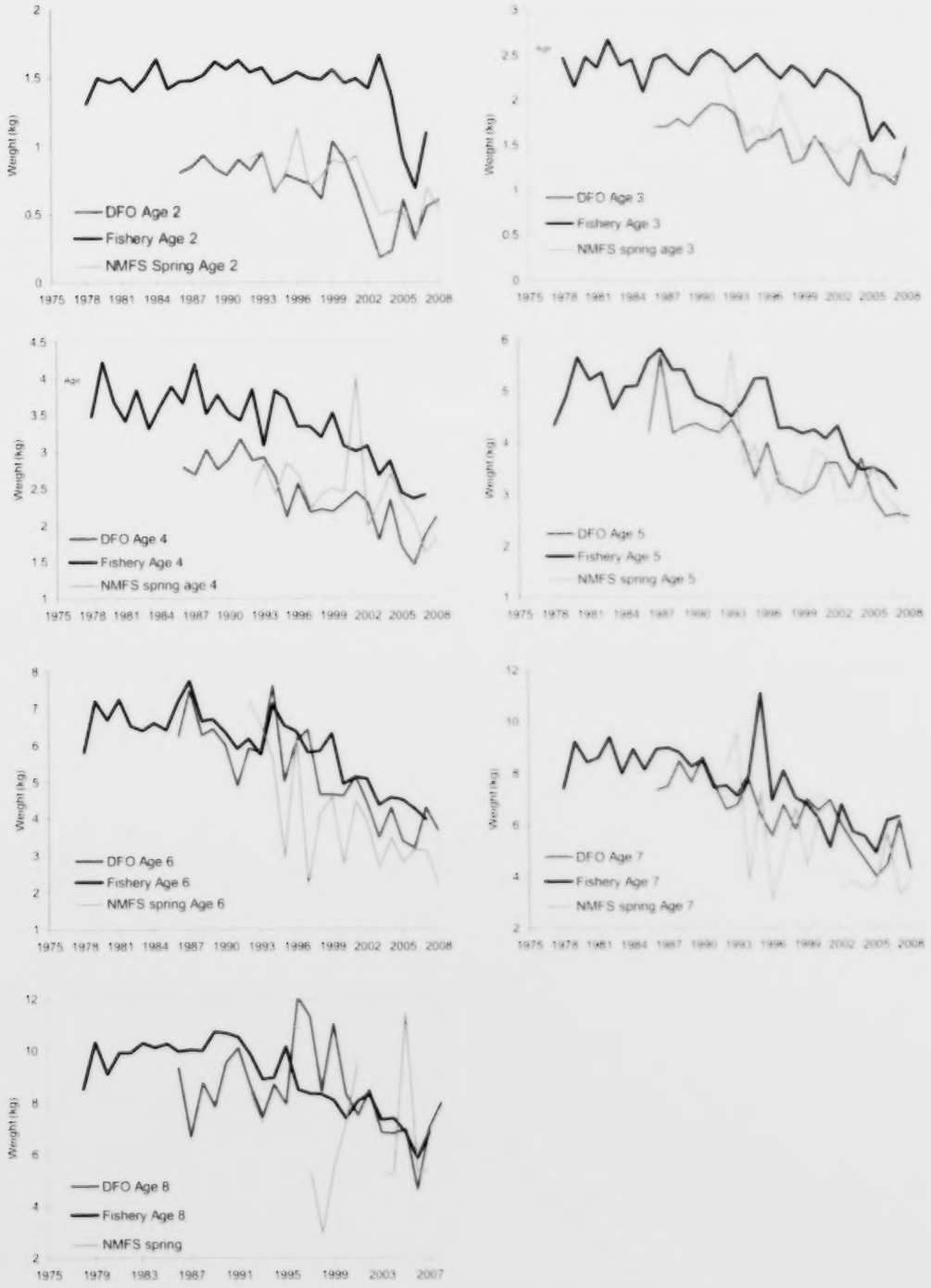

Figure 11. Average weights at ages 2 to 8 of cod from the DFO spring survey (1986 to 2007), eastern Georges Bank fishery (1978 to 2008) and NMFS spring survey (1992 to 2008).

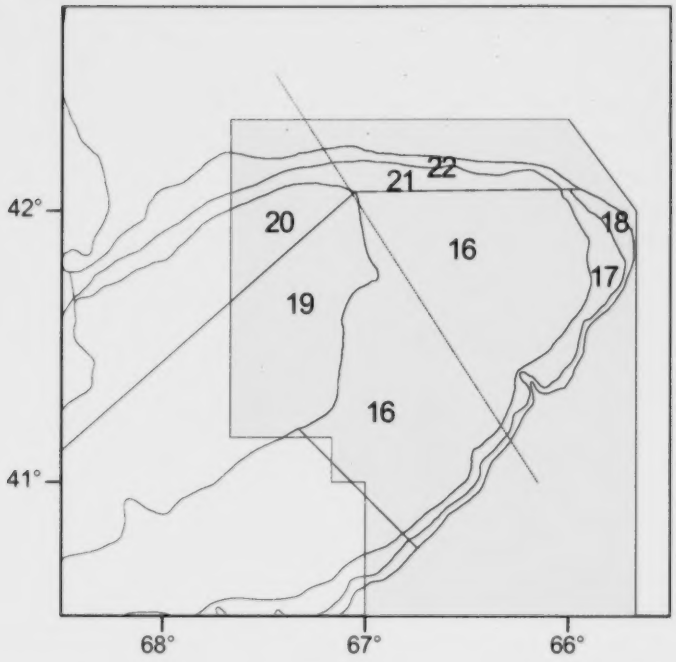

Figure 12. Stratification used for NMFS surveys. The eastern Georges Bank management unit is indicated by shading.

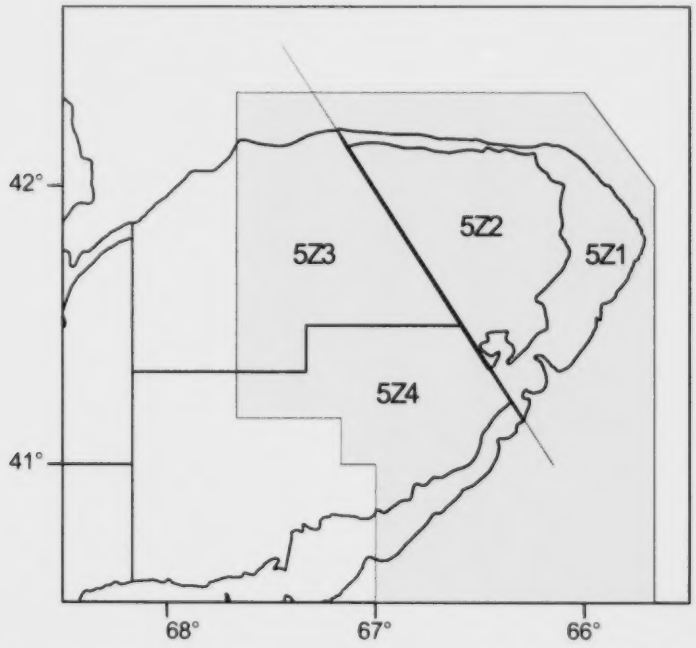

Figure 13. Stratification used for the DFO survey. The eastern Georges Bank management unit is indicated by shading.

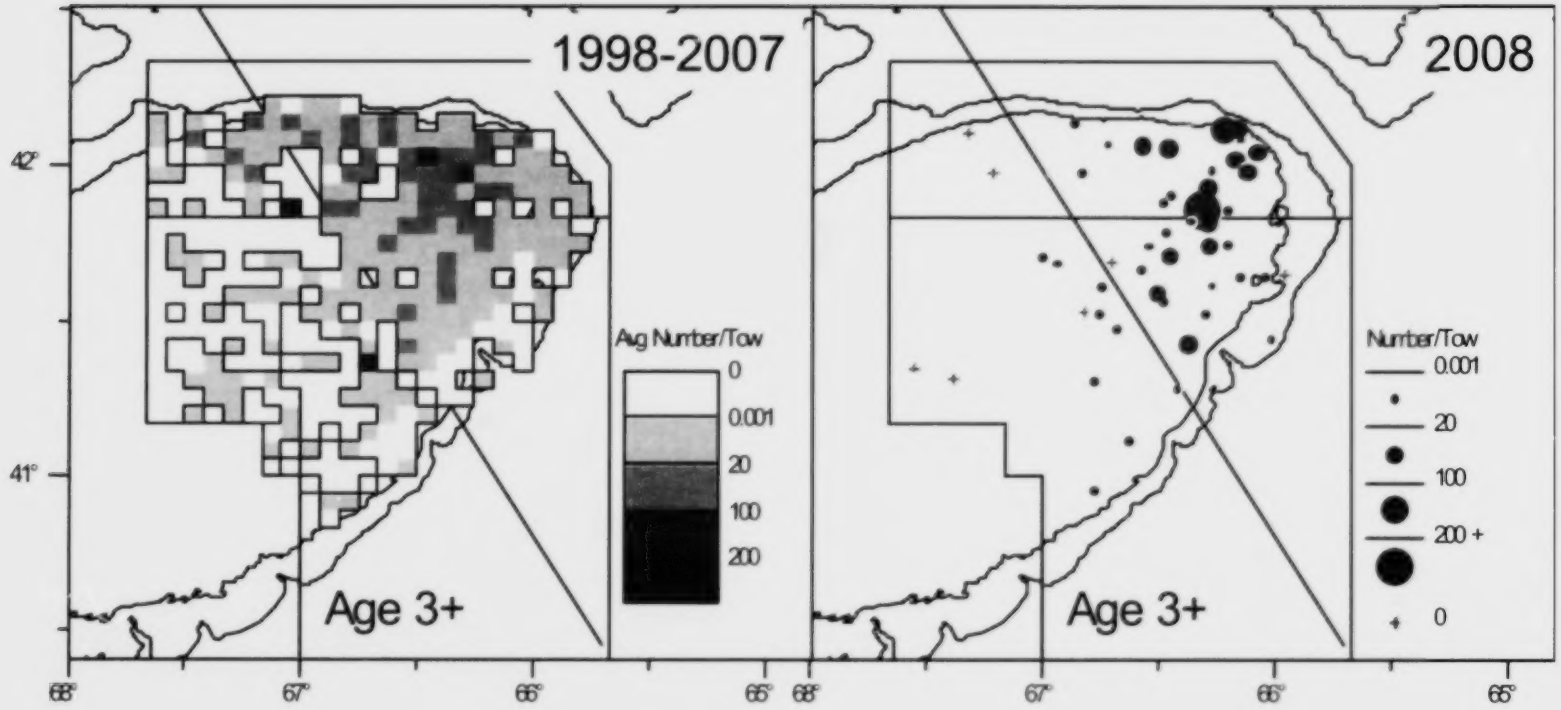

Figure 14. Spatial distribution of cod on eastern Georges Bank from the DFO survey for 2008 (right panel) compared to the average for 1998-2007 (left panel).

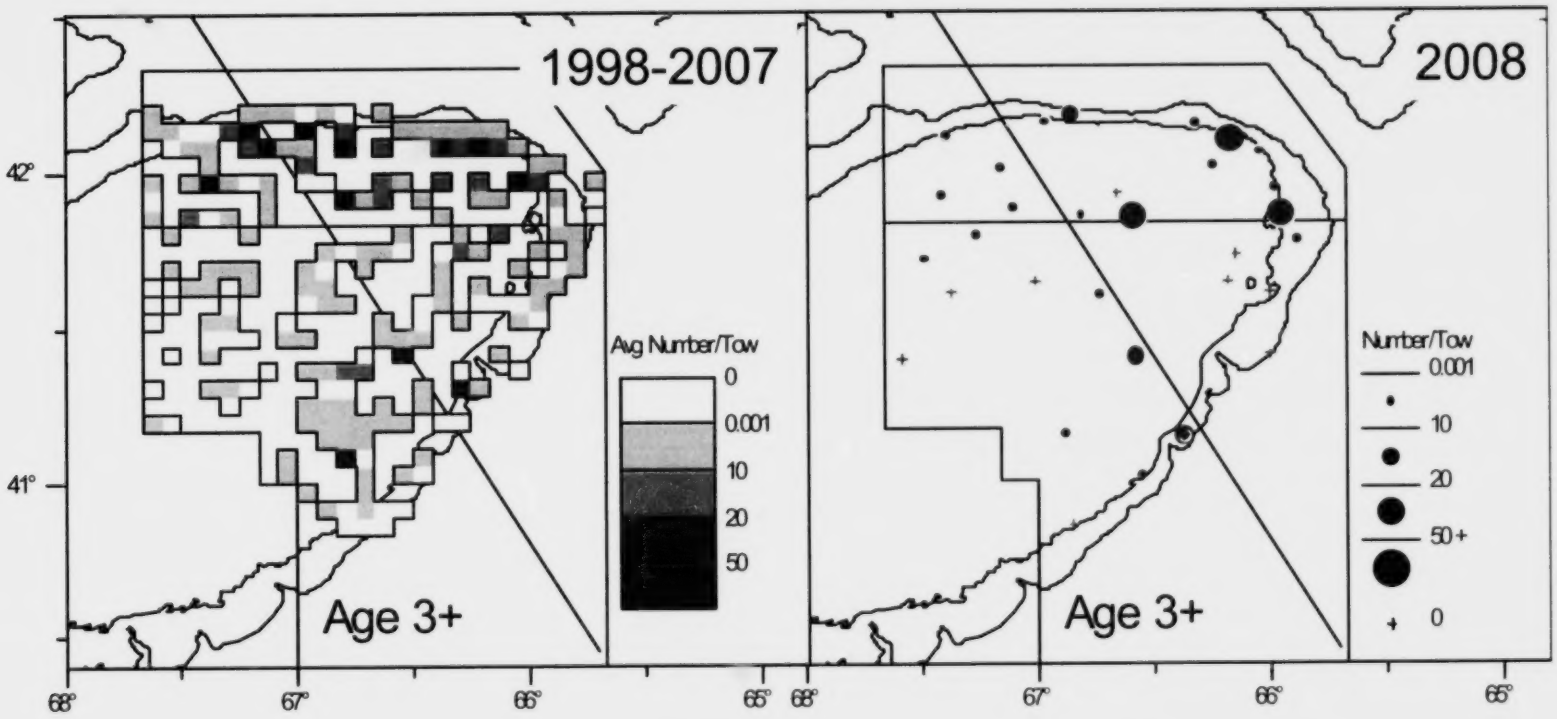

Figure 15. Spatial distribution of cod on eastern Georges Bank from the NMFS spring survey for 2008 (right panel) compared to the average for 1997-2007 (left panel).

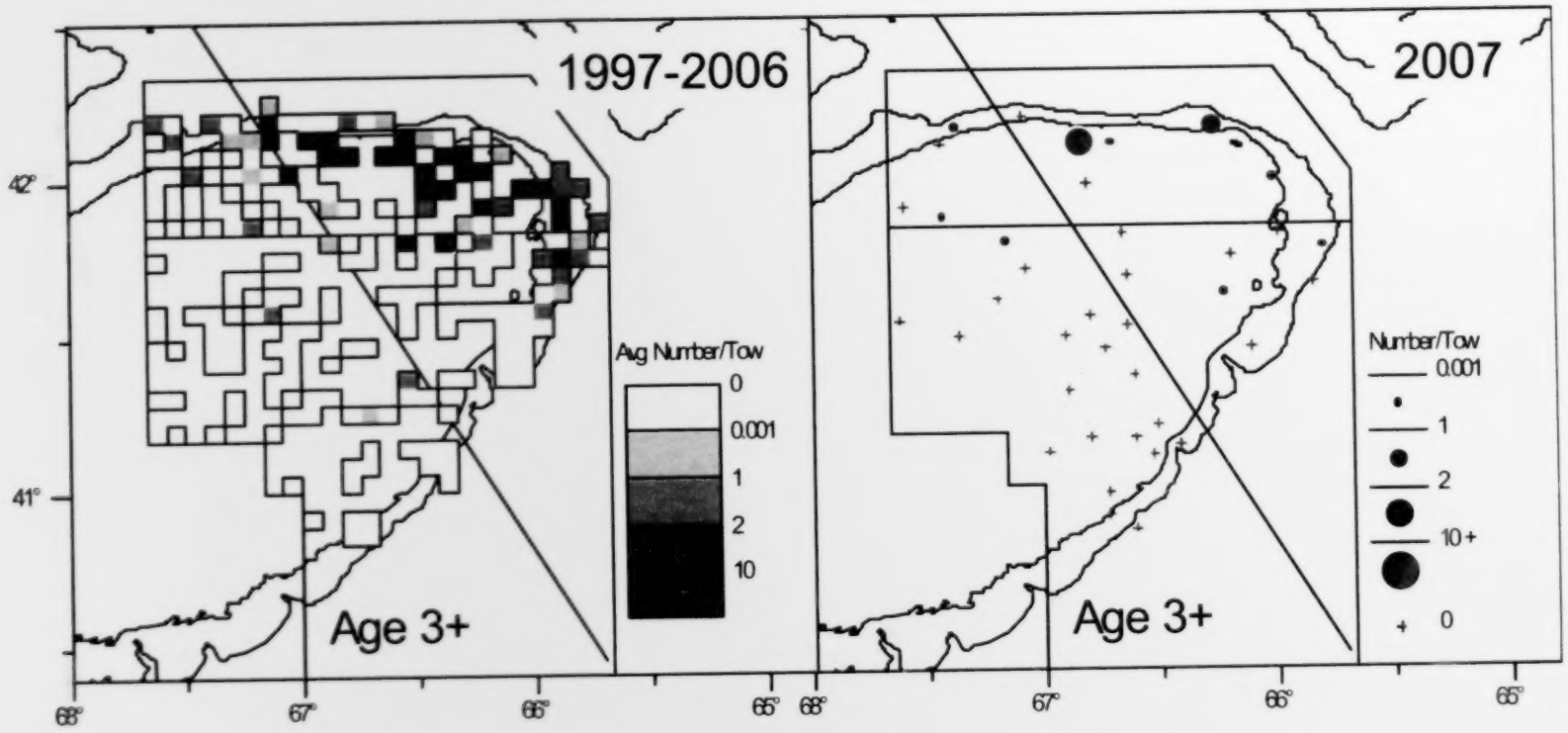

Figure 16. Spatial distribution of cod on eastern Georges Bank from the NMFS autumn survey for 2007 (right panel) compared to the average for 1997-2006 (left panel).

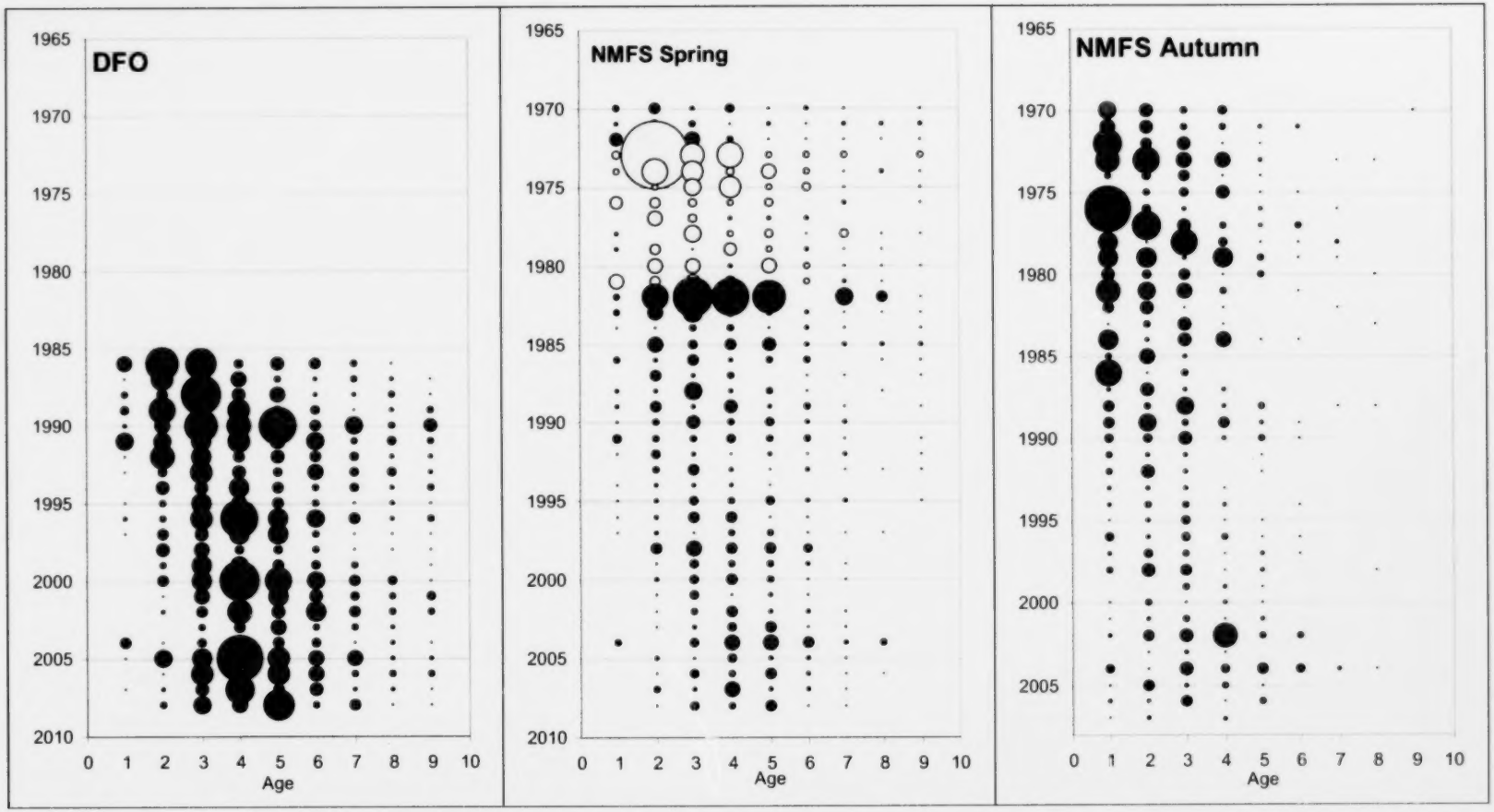

Figure 17. Survey abundance at age (numbers) of eastern Georges Bank cod. The bubble area is proportional to magnitude within each survey. Conversion factors to account for changes in door type and survey vessel were applied to the NMFS surveys. The NMFS spring survey was conducted using a modified Yankee 41 during 1978 to 1981 (yellow bubbles). The 2003 year class is identified with blue bubbles, and the 2005 year class with green bubbles.

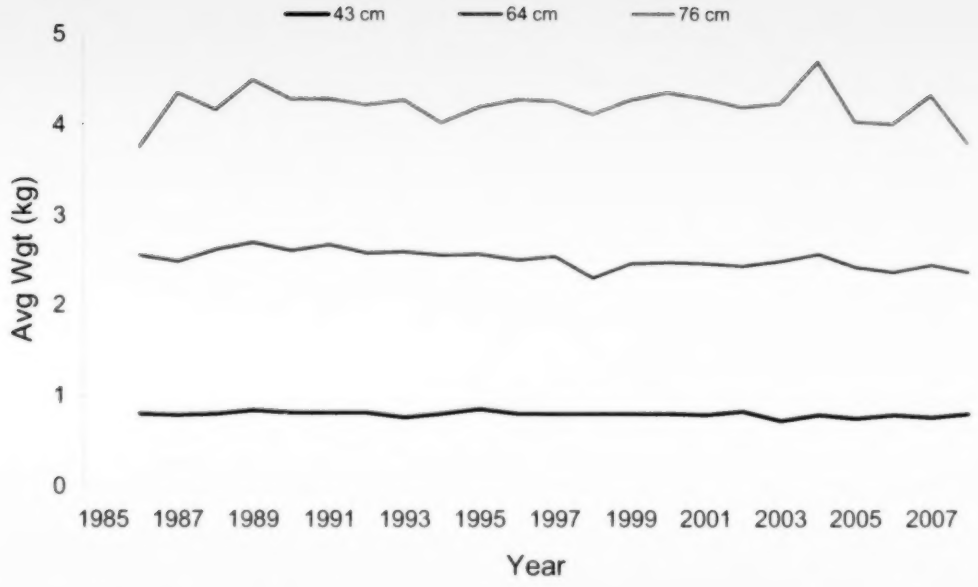

Figure 18. Condition, measured as average weight at three representative length groupings (center of 3 cm grouping used in label), for eastern Georges Bank cod from the DFO survey.

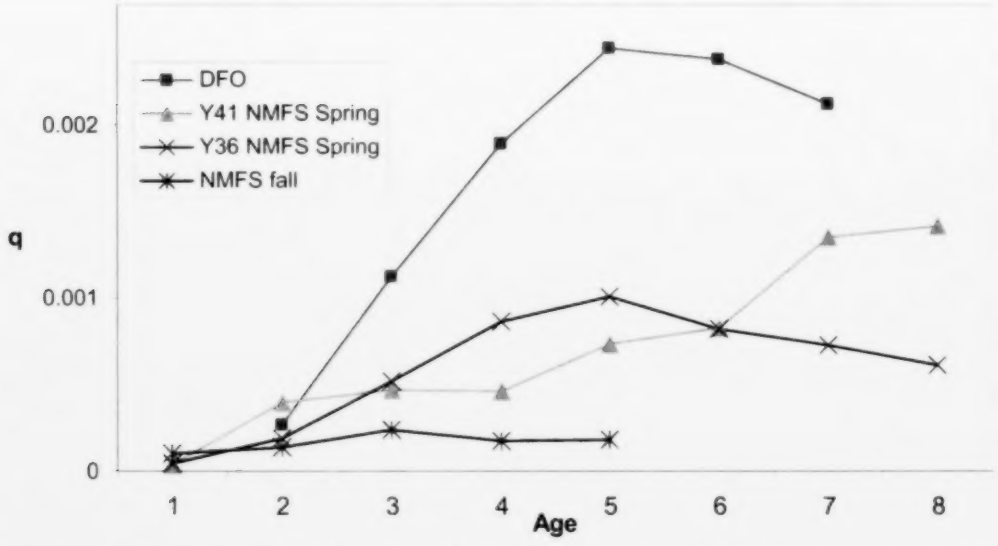

Figure 19. Survey catchability (q) for the DFO, NMFS Spring and NMFS Autumn surveys from the benchmark model formulation.

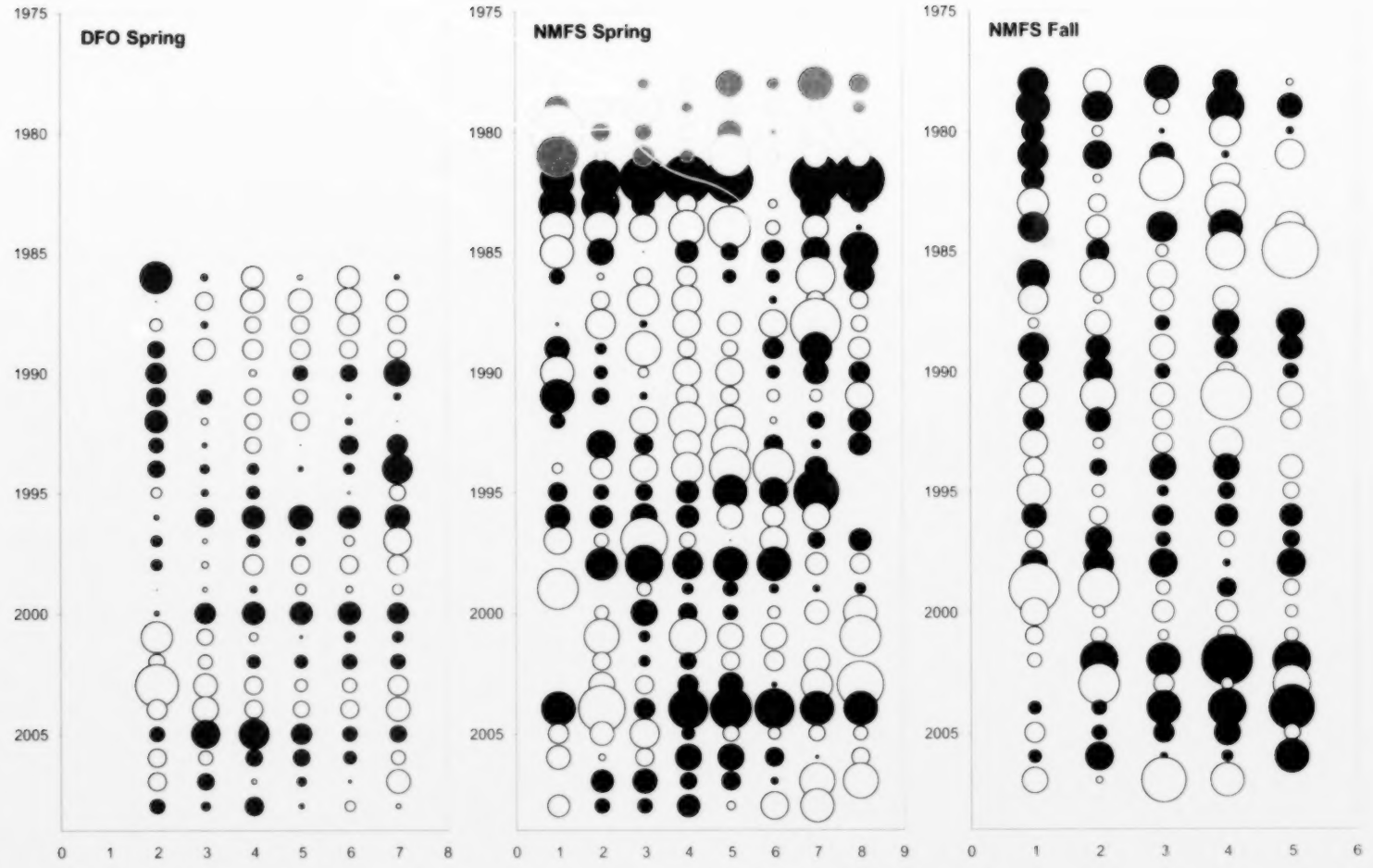

Figure 20. Residuals for the benchmark method by year and age group from survey indices for eastern Georges Bank cod. Solid bubbles indicate positive values, open bubbles indicate negative values and bubble area is proportional to magnitude. The NMFS spring survey was conducted using a modified Yankee 41 during 1978 to 1981 (pale blue bubbles).

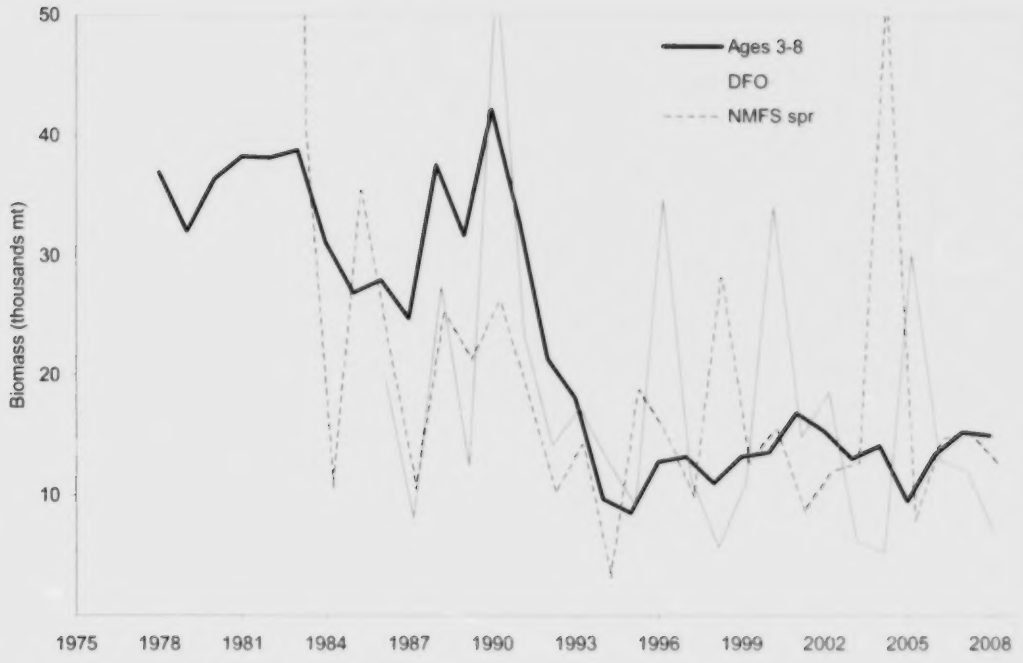

Figure 21. Overall fit of the benchmark model estimated biomass for ages 3-8 to DFO and NMFS spring surveys biomass of corresponding ages for eastern Georges Bank cod.

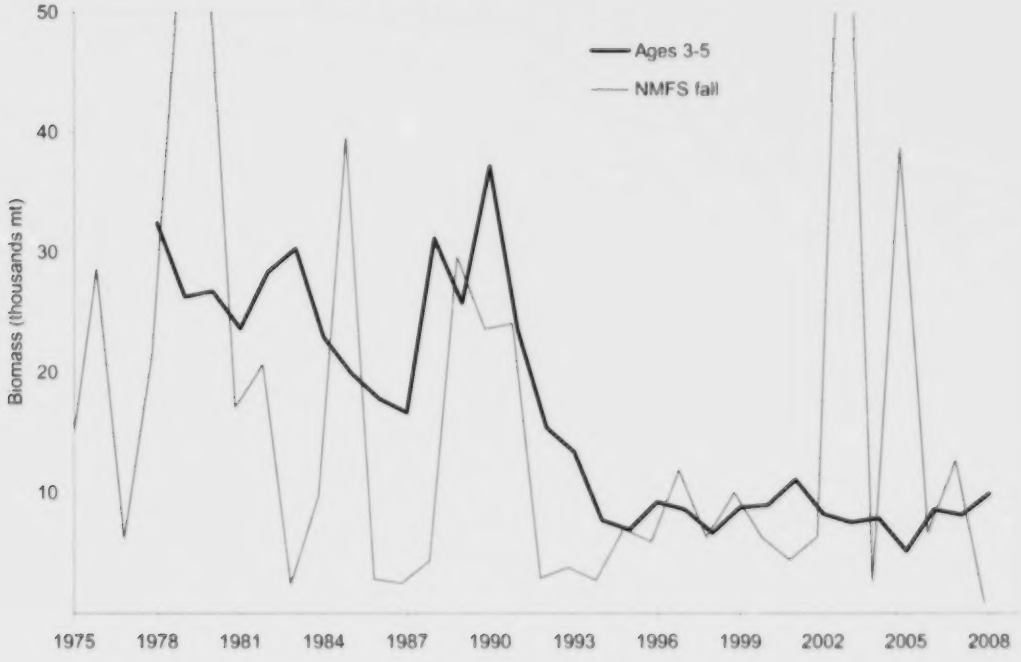

Figure 22. Overall fit of the benchmark model estimated biomass for ages 3-5 to NMFS fall surveys biomass of corresponding ages for eastern Georges Bank cod.

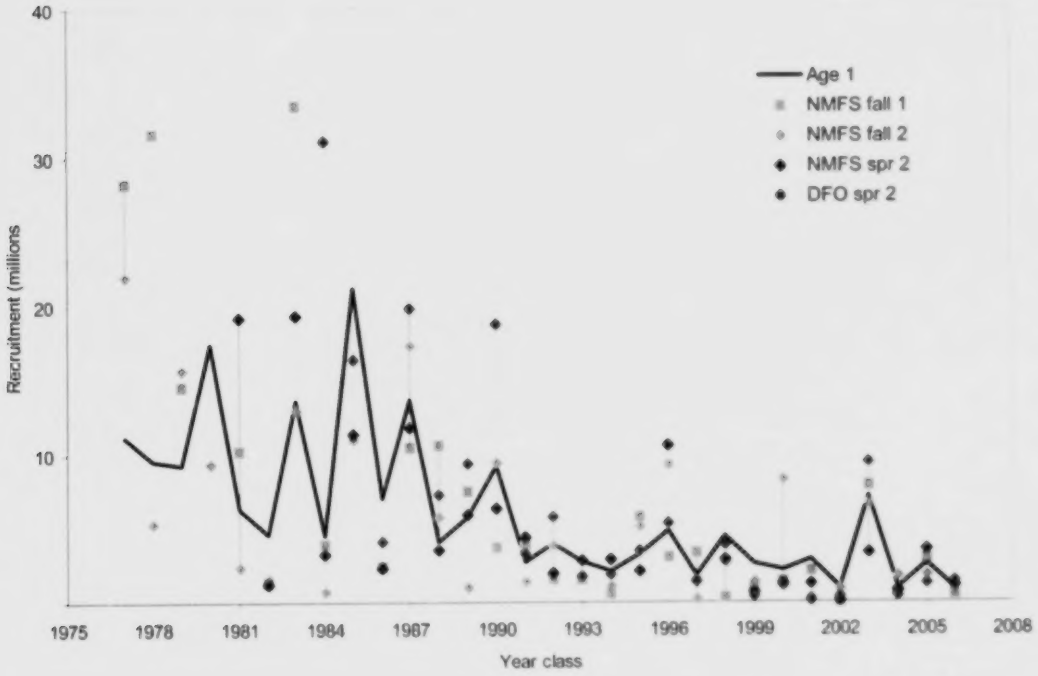

Figure 23. Overall fit of the benchmark model estimated recruitment at Age 1 to DFO, NMFS spring and NMFS fall surveys at ages 1 and 2 for eastern Georges Bank cod.

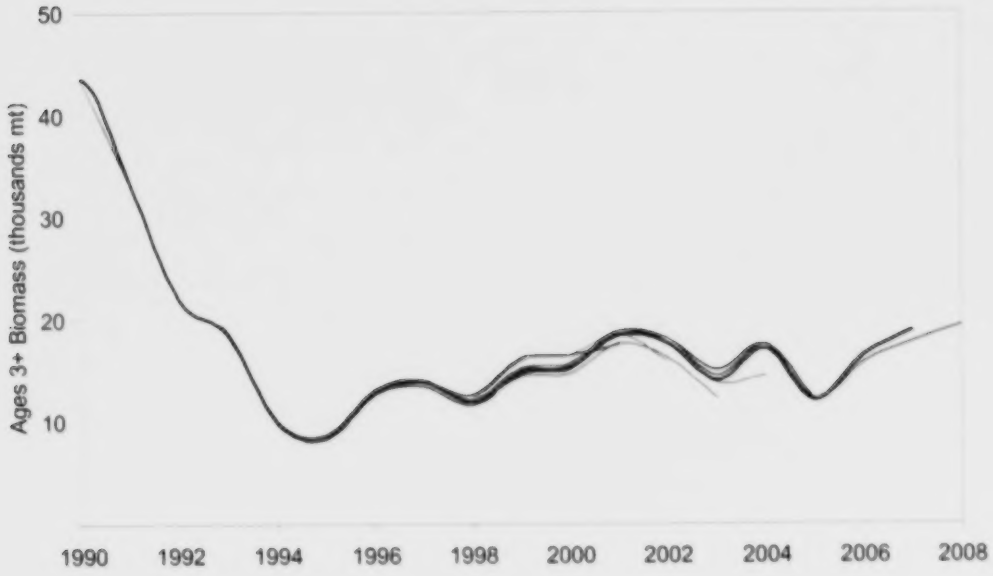

Figure 24. Retrospective pattern for ages 3+ biomass of eastern Georges Bank cod, benchmark method.

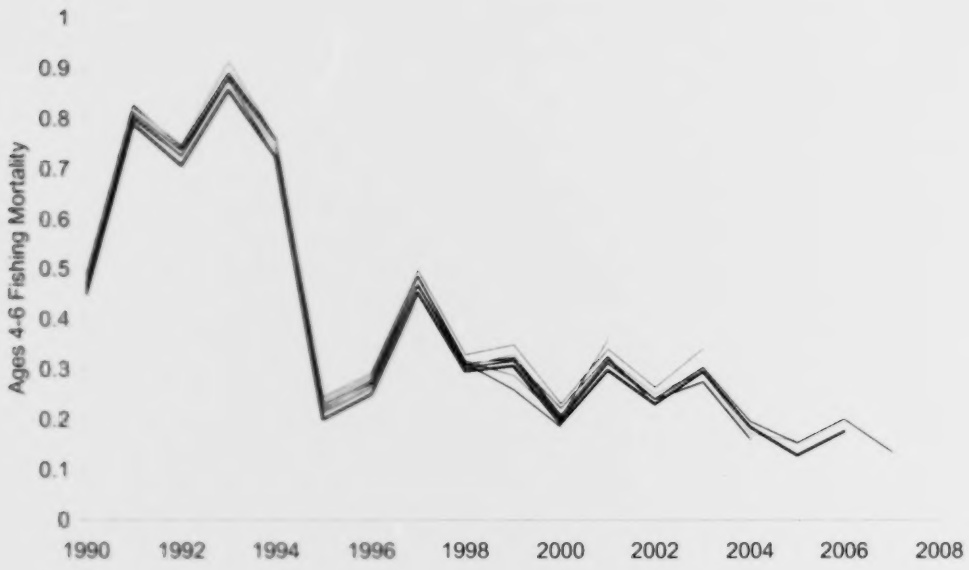

Figure 25. Retrospective pattern for ages 4-6 fishing mortality rate of eastern Georges Bank cod, benchmark method.

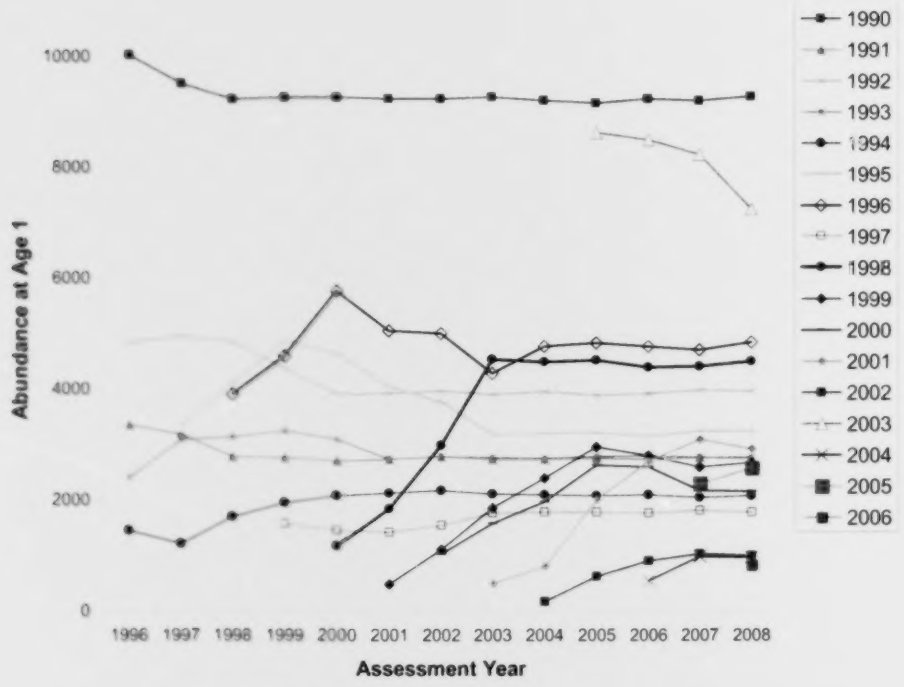

Figure 26. Retrospective pattern for Age 1 recruits of eastern Georges Bank cod, benchmark method.

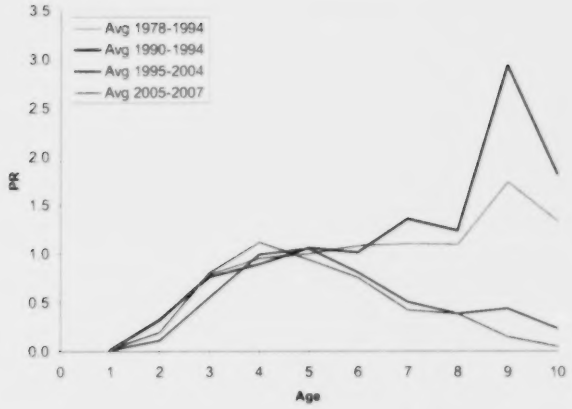

Figure 27. Fishery partial recruitment by age, benchmark model formulation.

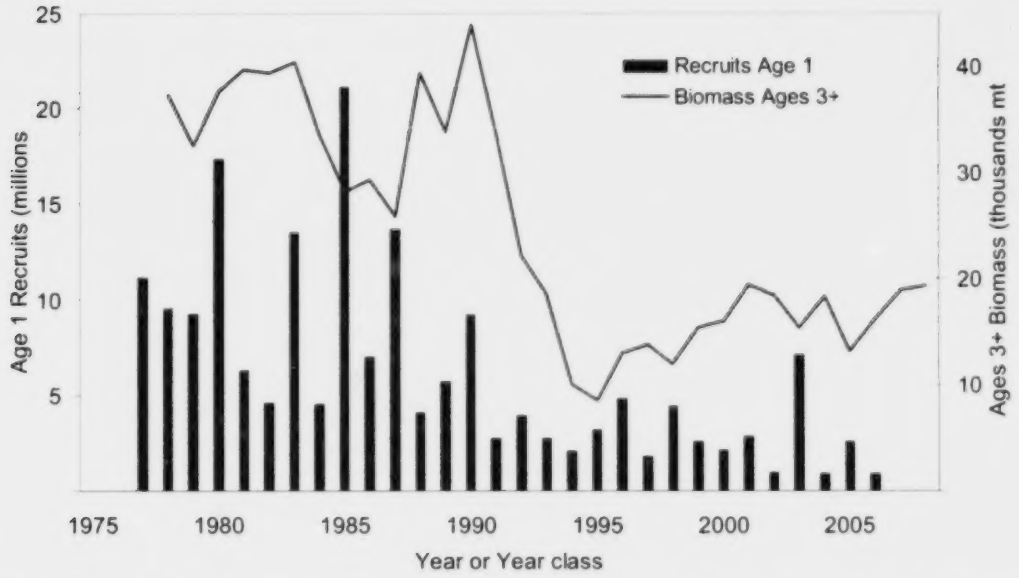

Figure 28. Adult biomass (ages 3+) and year class abundance at Age 1 for eastern Georges Bank cod, benchmark model formulation.

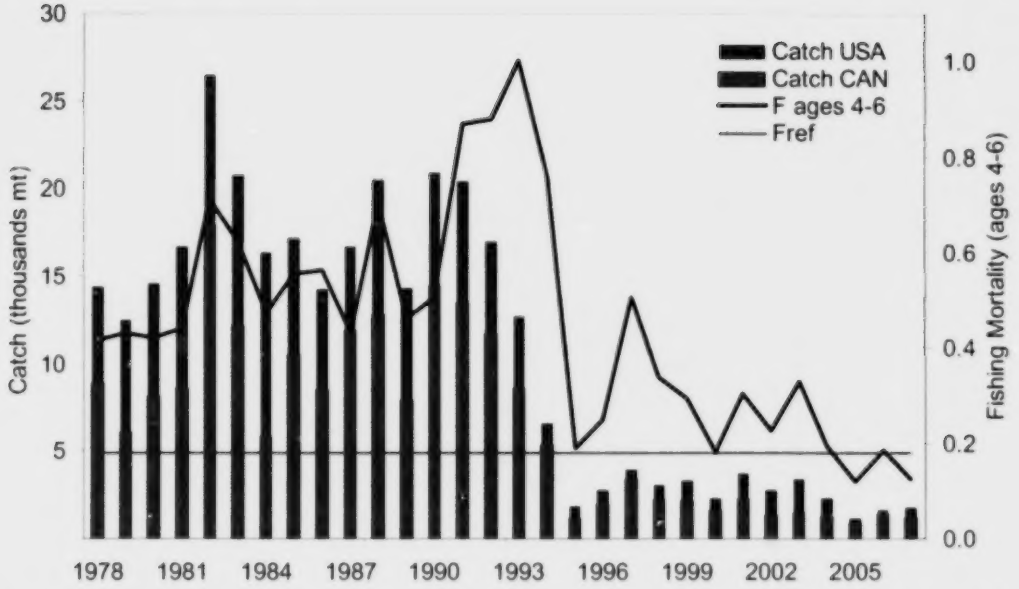

Figure 29. Fishing mortality rate at ages 4 to 6 and catches for eastern Georges Bank cod, benchmark model formulation. The established fishing mortality threshold reference, F_{ref}=0.18, is indicated.

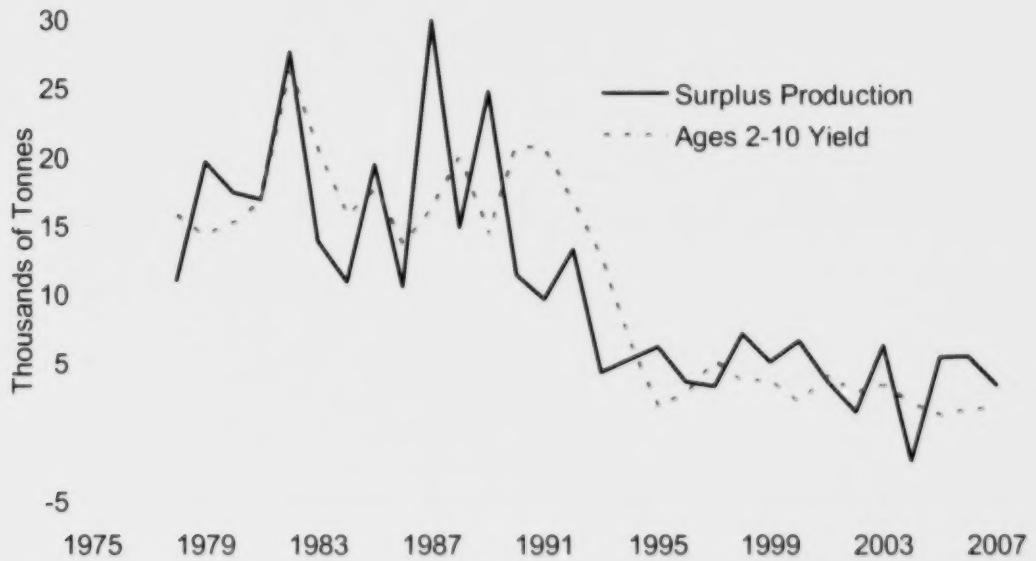

Figure 30. Surplus production of eastern Georges Bank cod compared to harvested yield, benchmark model formulation.

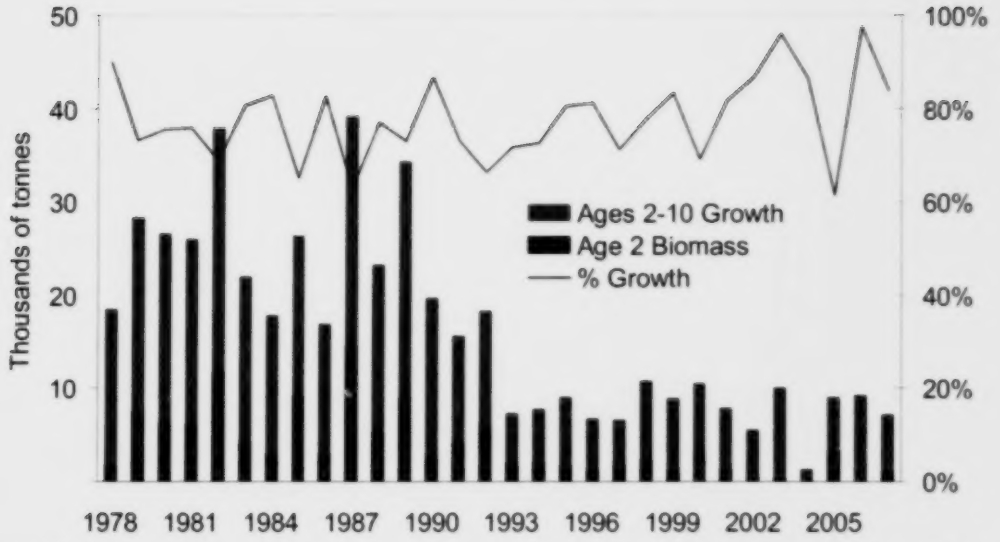

Figure 31. Components of annual production for eastern Georges Bank cod attributable to growth of ages 2 to 10 and to the amount contributed from incoming year classes at Age 2, benchmark model formulation.

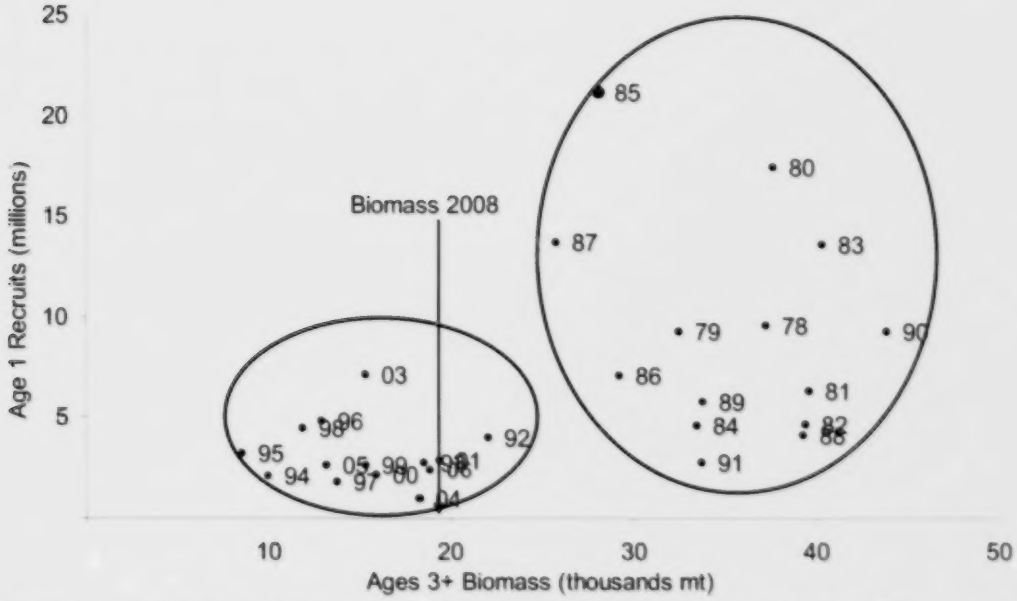

Figure 32. Relationship between adult biomass (ages 3+) and recruits at Age 1 for eastern Georges Bank cod, benchmark model formulation.

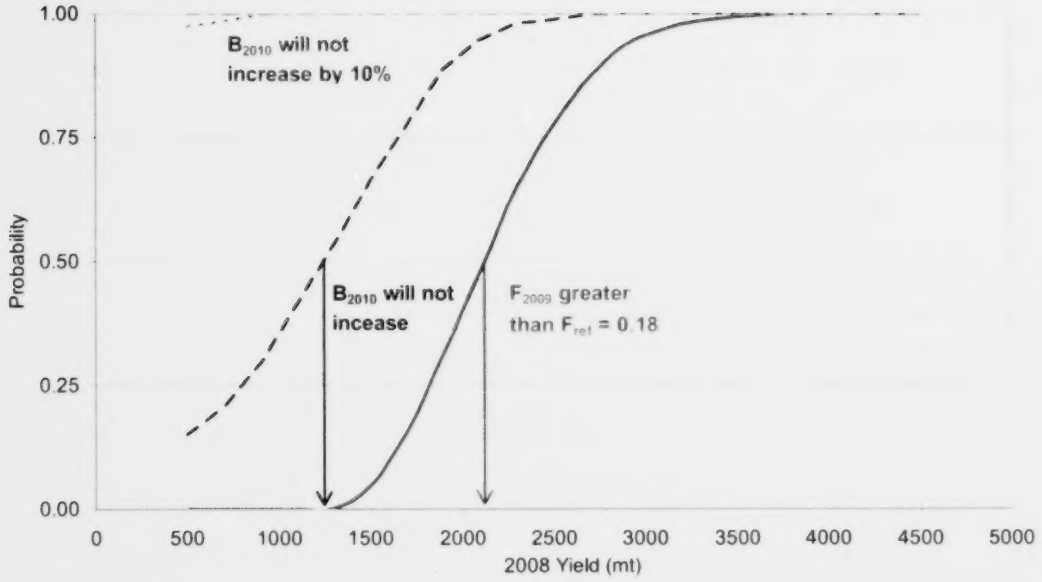

Figure 33. Risk of 2009 fishing mortality exceeding F_{ref} = 0.18 and risk of biomass not increasing or not increasing by 10% for alternative total yields of eastern Georges Bank cod, benchmark model formulation.

APPENDIX 1:

Additional Model Formulations Applied to Eastern Georges Bank Cod Data

There were some concerns regarding the 2002 benchmark model formulation so a preliminary examination was made of a number of other model formulations. Four of the model formulations that were explored were presented.

1. *Age Extended*
- Input the full range of catch at age out to Age 16
- F for the oldest age for which there is catch is calculated as the weighted average of the F on the two previous ages (eg. If the oldest fish caught in 1999 were Age 13, then the F on Age 13 would be calculated as the weighted average of the F on ages 11 and 12)
- In 2008, N is estimated for ages 2 to 8

2. *F Averaged on Age 10*
- This is the model formulation used prior to the 2002 Benchmark
- Input the catch to Age 10
- F for Age 10 is calculated as the weighted average of F on ages 8 and 9 from 1978 to 2007.
- In 2008, N is estimated for ages 2 to 11

3. *F Averaged on Age 10 and 6*
- Input catch to Age 10
- F for Age 10 is the weighted average of F on ages 8 and 9 from 1978 to 2000
- F for Age 6 is the weighted average of F on ages 4 and 5 from 1997 to 2007
- In 2008, N is estimated for ages 2 to 8.

4. *F Averaged on Age 10 with Split Indices*
- Same setup as F Averaged on Age 10 method, but the survey indices are split into two time series: before 1995 and 1995 and above.

1. Age Extended

The "Age Extended" model formulation was an attempt to get rid of the conundrum of a model that predicts old fish in the population that cannot be caught. It included the catch at age data at all ages, with no plus groups. This model formulation produced a survey catchability (q) at age that was not domed for all surveys (Figure 1.1) and a PR pattern for the fishery that was flat topped (Figure 1.2). It did, however, produce a strong retrospective pattern. The retrospective seems to have improved in the last three years (Figure 1.3). The beginning of year population abundance, biomass and annual fishing mortality tables from this model run are shown in Tables 1.1 to 1.3.

The low catches at older ages led to a lot of variability in the F values at those ages, and this caused some problems with the calculation of F on the oldest ages. No projections were done using this model formulation.

2. F Averaged on Age 10

The "F Averaged on Age 10" method was the model formulation that was used prior to the 2002 Benchmark. It produced a DFO survey catchability at age that was not domed, and a NMFS spring survey q that was only slightly domed (Figure 1.4). The fishery PR pattern was flat topped until 2005, when it became domed (Figure 1.5). As with the Age Extended Model, there was a strong retrospective pattern (Figure 1.6). Again, this retrospective seemed better in the most recent years. The beginning of year population abundance, biomass and annual fishing mortality tables from this model run are shown in Table 1.4 to 1.6. Projections were made using this model formulation (Table 1.7). It predicted a 26% lower 3+ biomass in 2009 and a 23% lower 3+ biomass in 2010 and a projected catch biomass for 2009 that was 23% lower than the benchmark method.

The low catches at older ages in recent years continued to be very influential on the F calculation (Table 5, 1.5) and led to a lot of variability.

3. F Averaged on Age 10 and 6

The "F Averaged on Age 10 and 6" method was a modification of the "F Averaged on Age 10" matrix. It differed in that F on Age 6 in the most recent years (1997 to 2005) was calculated as the weighted average of F on ages 4 and 5. This lessened the impact of the low catches at older ages in recent years and did not force the fishery PRs on ages 7 to 10 to be flat in the recent years. The survey catchabilities were not domed (Figure 1.7), and neither were the fishery PRs prior to 1995 (Figure 1.8). The fishery partial recruitment pattern since 2000 was domed. In exploring the partial recruitment patterns produced by this model, it was noted that there appears to be some issue with the data between 1994 and 1996, coincident with a low population biomass, the instigation of U.S.A. Closed Area 2 and the establishment of stricter Canadian quotas. It is possible that the catch data for this period does not fully capture the amount of discarding that may have been going on at that time.

The beginning of year population abundance, biomass and annual fishing mortality tables from this model run are shown in Table 1.8 to 1.10. Projections made using this model formulation predicted a 16% lower 3+ biomass in 2009 and a 14% lower 3+ biomass in 2010 and a projected catch biomass for 2009 that was 10% lower than the benchmark method (Table 1.11).

4. F Averaged on Age 10 with Split Indices

This model formulation calculated the F at Age 10 on a weighted average of the F values at ages 8 and 9 and used survey indices split after 1994, the date when new management measures were introduced and the stock was at a low level. The survey catchabilities at age from this formulation were not domed (Figure 1.9) and the fishery partial recruitment by age was not domed prior to 2005 (Figure 1.10). The beginning of year population abundance, biomass and annual fishing mortality tables are shown in tables 1.12 to 1.14. Of all model formulations tried, this one produced the lowest estimates for the 3+ biomass in recent years (Table 1.15).

Projections using this formulation predicted a 64% lower 3+ biomass in 2009 and a 53% lower 3+ biomass in 2010 and a projected catch biomass for 2009 that was 45% lower than the "Around the Corner" benchmark method (Table 1.15). This method produced very high F values in the recent time period, well above the F_{ref} of 0.18, despite the restrictive management measures that have been in place. These high F values seem implausible given the comparatively low catches.

Summary of Model Exploration

There were merits to some of the model formulations that were tried, but there were problems with all of them. Further exploration of these and other formulations and an examination of the catch data from the mid-1990's would be appropriate.

Table 1.1. Beginning of year population abundance (numbers in thousands) for eastern Georges Bank cod using the full age range of the catch data and averaging the terminal F in each year as the weighted average of F on the two previous years ("Age Extended" method).

Year	Age Group																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	1+	3+
1978	11153	2229	10555	3450	1027	311	343	42	39	9	7	4	0	1	3	1	29173	15791
1979	9485	9129	1716	5426	1859	566	156	206	15	21	4	4	2	0	1	1	28592	9977
1980	9182	7756	6728	1040	2825	1025	327	107	127	9	15	3	3	2	0	0	29151	12212
1981	17154	7517	5454	4154	612	1485	528	169	70	74	3	9	1	2	1	0	37235	12564
1982	6291	14027	5605	3157	2270	360	679	279	80	25	44	2	7	1	2	1	32829	12511
1983	4579	5146	9062	3070	1303	903	126	247	88	32	9	18	0	4	0	1	24588	14863
1984	13512	3713	3025	4353	1195	648	485	75	138	37	21	6	10	0	0	0	27218	9994
1985	4533	11053	2796	1654	2349	519	270	190	34	48	7	5	1	2	0	0	23461	7876
1986	21124	3700	6530	1193	787	1077	224	135	66	15	16	2	1	1	1	0	34870	10046
1987	7053	17269	2733	3370	514	370	521	130	75	31	9	6	0	1	1	1	32085	7762
1988	13630	5762	10842	1462	1773	292	194	277	74	40	19	5	5	0	1	1	34376	14984
1989	3881	11150	4431	5630	624	690	112	69	100	24	16	5	1	2	0	0	26737	11705
1990	5446	3134	8389	3027	2970	339	287	42	34	37	9	6	1	1	2	0	23725	15145
1991	8685	4451	1919	3990	1612	1359	173	125	25	15	10	5	2	0	1	0	22374	9238
1992	2445	7080	2992	853	1532	473	410	59	52	5	6	2	2	0	0	0	15914	6388
1993	3372	1915	3595	1330	313	449	165	129	26	19	2	2	1	1	0	0	11319	6032
1994	2141	2754	1155	1176	368	66	74	37	23	1	1	0	2	0	0	0	7798	2903
1995	1349	1751	2086	509	295	83	18	9	7	1	0	0	0	2	0	0	6110	3010
1996	2357	1103	1382	1496	309	162	55	11	5	5	1	0	0	0	1	0	6886	3426
1997	3613	1926	865	917	865	182	88	35	6	2	4	1	0	0	0	1	8505	2965
1998	1410	2956	1454	516	383	297	50	23	12	2	1	3	0	0	0	0	7107	2741
1999	3975	1154	2327	848	245	134	95	17	5	5	1	0	2	0	0	0	8809	3680
2000	1705	3251	888	1419	369	102	55	31	4	2	1	0	0	1	0	0	7829	2873
2001	2160	1394	2608	623	860	186	53	27	15	1	2	0	0	0	1	0	7930	4376
2002	2778	1767	1040	1711	329	369	64	17	7	7	1	1	0	0	0	1	8092	3547
2003	785	2271	1432	734	1061	182	171	30	7	2	5	0	1	0	0	0	6680	3625
2004	5967	641	1830	1012	353	516	84	67	10	3	1	4	0	1	0	0	10489	3881
2005	803	4883	512	1379	691	169	307	39	35	4	2	0	3	0	0	0	8829	3143
2006	2264	656	3918	369	955	515	110	216	22	24	2	2	0	2	0	0	9056	6136
2007	733	1848	519	2981	232	613	378	74	161	16	19	2	1	0	2	0	7579	4998
2008	2500	598	1444	349	2076	162	424	300	54	126	13	15	1	1	0	2	8066	4968

Table 1.2 Annual fishing mortality rate for eastern Georges Bank cod using the full age range of the catch data and averaging the terminal F in each year as the weighted average of F on the two previous years ("Age Extended" method).

Year	Age															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	4-6
1978	0	0.062	0.465	0.418	0.397	0.490	0.309	0.792	0.397	0.563	0.271	0.439	0.330	0.426	0.397	0.481
1979	0	0.105	0.301	0.453	0.395	0.348	0.172	0.280	0.312	0.176	0.152	0.144	0	0	0	0.330
1980	0	0.152	0.282	0.331	0.443	0.464	0.459	0.231	0.341	1.011	0.281	0.599	0	0	0	0.385
1981	0	0.093	0.347	0.405	0.330	0.583	0.437	0.552	0.838	0.323	0.212	0.043	0	0	0	0.461
1982	0	0.237	0.402	0.685	0.722	0.852	0.811	0.951	0.711	0.771	0.686	2.937	0.485	0.989	0.553	0.804
1983	0.01	0.331	0.533	0.744	0.498	0.422	0.316	0.380	0.657	0.226	0.273	0.362	0	2.283	0	0.472
1984	0	0.084	0.404	0.417	0.635	0.675	0.735	0.605	0.851	1.457	1.205	1.366	1.220	0	1.220	0.613
1985	0	0.326	0.652	0.543	0.580	0.642	0.495	0.854	0.629	0.928	0.968	1.121	0	1.121	1.121	0.623
1986	0	0.103	0.462	0.641	0.555	0.526	0.338	0.385	0.558	0.315	0.753	3.049	0	0	0	0.489
1987	0	0.265	0.426	0.442	0.367	0.443	0.433	0.372	0.421	0.312	0.454	0.051	0	0	0	0.411
1988	0	0.063	0.455	0.651	0.744	0.762	0.835	0.816	0.911	0.742	1.142	1.179	0.525	0.847	0.530	0.761
1989	0.01	0.085	0.181	0.439	0.410	0.679	0.782	0.500	0.805	0.744	0.687	1.169	0.090	0.174	0	0.562
1990	0	0.291	0.543	0.430	0.582	0.471	0.628	0.306	0.609	1.103	0.395	0.927	1.131	0	1.131	0.483
1991	0	0.197	0.610	0.757	1.026	0.998	0.876	0.670	1.435	0.707	1.544	0.945	1.339	1.058	1.301	0.865
1992	0.04	0.478	0.611	0.801	1.028	0.854	0.958	0.618	0.810	0.750	0.805	0.888	0.823	0	0	0.852
1993	0	0.305	0.918	1.085	1.364	1.608	1.290	1.525	2.834	3.248	3.009	0	3.009	0	0	1.374
1994	0	0.078	0.620	1.181	1.286	1.113	1.929	1.403	2.759	2.404	2.741	0	0	0	0	1.382
1995	0	0.036	0.133	0.300	0.401	0.210	0.307	0.464	0.256	0.009	0.000	0	0	0	0	0.336
1996	0	0.043	0.210	0.348	0.329	0.411	0.268	0.322	0.577	0.027	0.158	0	0	0.105	0	0.335
1997	0	0.081	0.316	0.674	0.867	1.097	1.159	0.870	1.011	0.504	0.156	0.164	0.157	0	0	0.933
1998	0	0.039	0.339	0.544	0.848	0.942	0.853	1.250	0.570	0.979	1.598	0.251	0.627	0	0	0.887
1999	0	0.062	0.294	0.633	0.673	0.697	0.907	1.399	0.573	2.161	0.233	0	0.009	0	0	0.862
2000	0	0.020	0.155	0.301	0.485	0.462	0.518	0.556	0.785	0.141	1.166	0.042	0.118	0.062	0	0.464
2001	0	0.093	0.222	0.437	0.647	0.860	0.926	1.185	0.515	0.590	0.159	0.428	0.055	0.171	0	0.811
2002	0	0.010	0.149	0.278	0.395	0.565	0.578	0.648	0.945	0.261	1.101	0.325	0.371	0.327	0	0.493
2003	0	0.015	0.147	0.531	0.520	0.578	0.736	0.877	0.615	0.997	0.048	0.350	0	0.350	0	0.648
2004	0	0.024	0.083	0.181	0.536	0.320	0.564	0.447	0.635	0.323	0.354	0	0	0	0	0.409
2005	0	0.020	0.129	0.167	0.094	0.227	0.154	0.366	0.178	0.409	0.006	0.286	0.051	0	0	0.202
2006	0	0.034	0.073	0.266	0.244	0.109	0.200	0.090	0.127	0.063	0.127	0.127	0	0	0	0.182
2007	0	0.047	0.196	0.162	0.156	0.168	0.033	0.116	0.046	0.032	0.006	0	0	0	0	0.127

Table 1.3. Beginning of year population biomass (thousands of mt) for eastern Georges Bank cod using the full age range of the catch data and averaging the terminal F in each year as the weighted average of F on the two previous years ("Age Extended" method).

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1979	1379	1852	18382	9615	4403	1914	2547	354	429	112	113	41099	37868
1980	1173	7585	2988	15121	7970	3485	1157	1743	172	261	71	41726	32968
1981	1135	6444	11717	2898	12109	6317	2430	908	1415	114	246	45734	38155
1982	2121	6245	9499	11578	2622	9154	3923	1433	774	910	46	48304	39938
1983	778	11654	9761	8798	9728	2219	5044	2362	886	303	739	52272	39840
1984	566	4275	15781	8556	5586	5563	935	2090	979	394	157	44882	40041
1985	1671	3084	5268	12130	5121	3995	3603	636	1534	459	352	37854	33098
1986	560	9183	4868	4610	10067	3196	2009	1611	373	593	120	37190	27447
1987	2556	2982	11100	3319	3306	6697	1634	1255	919	207	263	34239	28701
1988	1058	14593	4650	9049	2918	2770	3897	869	759	217	147	40927	25276
1989	2075	5362	19356	4415	7393	1829	1640	2415	908	571	212	46176	38739
1990	552	9276	7555	15531	2689	4439	850	540	1135	250	232	43047	33219
1991	1169	2467	15461	8776	12956	2036	2461	398	463	529	170	46887	43250
1992	762	3991	3745	12638	6841	6652	1308	1260	251	237	134	37819	33066
1993	301	5795	5792	2455	6422	2789	2697	508	520	0	152	27430	21335
1994	237	1827	6600	3881	1392	2609	1113	953	242	161	41	19055	16991
1995	137	1817	1632	3116	1467	500	567	322	203	23	13	9797	7843
1996	227	1374	3221	1074	973	417	112	69	89	18	2	7576	5974
1997	107	833	2153	3830	1234	989	306	128	54	65	19	9719	8779
1998	403	1388	1451	1991	2761	1164	593	390	64	34	67	10306	8515
1999	110	1809	1875	1144	1182	1381	287	190	97	16	16	8107	6187
2000	620	1187	3104	1848	731	623	658	191	45	93	9	9110	7302
2001	0	2943	1414	3263	1150	471	356	260	40	34	7	9940	6996
2002	22	954	3644	1522	3086	954	365	199	151	13	20	10932	9956
2003	0	748	1221	3945	1183	1627	383	145	67	85	9	9414	8665
2004	0	409	1478	1311	3279	632	898	201	56	0	65	8330	7921
2005	94	146	2663	2364	1298	2209	383	456	106	29	9	9757	9517
2006	9	2931	604	2344	2008	570	1217	268	227	20	25	10224	7284
2007	73	206	4483	535	2438	1643	485	993	127	167	15	11165	10886
2008	39	1012	544	5554	599	2620	2321	517	1287	118	112	14722	13670

Table 1.4. Beginning of year population abundance (numbers in thousands) for eastern Georges Bank cod using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 ("F averaged on Age 10" method).

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1978	11131	2210	10563	3506	991	307	279	56	26	9	0	29078	15737
1979	9504	9112	1700	5432	1905	536	152	154	27	11	4	28538	9922
1980	9231	7772	6714	1028	2830	1062	303	105	85	19	6	29154	12151
1981	17355	7557	5467	4143	601	1490	558	149	68	39	10	37438	12526
1982	6287	14192	5638	3167	2260	352	682	304	64	23	16	32984	12505
1983	4581	5142	9196	3097	1312	895	119	250	108	19	8	24727	15004
1984	13532	3715	3022	4462	1216	655	478	70	140	54	10	27355	10108
1985	4532	11070	2797	1652	2438	536	276	185	29	50	20	23585	7984
1986	21113	3699	6543	1194	785	1150	238	139	62	11	17	34952	10140
1987	7023	17260	2733	3381	515	368	581	142	79	28	6	32115	7832
1988	13625	5737	10835	1461	1782	293	193	325	83	43	16	34395	15032
1989	3880	11147	4411	5624	624	697	112	68	140	32	18	26753	11726
1990	5452	3133	8386	3011	2965	339	292	42	33	69	16	23738	15154
1991	8672	4455	1918	3988	1599	1355	173	130	26	15	36	22366	9239
1992	2443	7070	2996	853	1530	462	407	59	56	5	6	15887	6374
1993	3348	1912	3587	1333	313	447	156	126	26	22	2	11273	6012
1994	2148	2734	1153	1169	370	65	72	30	21	1	3	7768	2885
1995	1352	1756	2069	508	290	85	17	8	2	0	0	6087	2979
1996	2406	1105	1387	1482	308	158	57	10	4	0	0	6916	3406
1997	3748	1966	867	921	854	181	84	36	6	1	0	8664	2951
1998	1653	3066	1486	518	386	289	49	20	13	2	0	7481	2762
1999	4121	1353	2417	875	247	137	88	17	3	6	0	9263	3789
2000	2155	3371	1051	1493	390	103	57	26	3	1	1	8650	3124
2001	1767	1763	2706	756	920	203	54	28	10	1	0	8209	4679
2002	2323	1445	1341	1791	4[illegible]	418	79	18	8	3	0	7865	4096
2003	793	1899	1168	980	1127	270	211	41	8	3	1	6503	3811
2004	6013	648	1526	796	554	570	156	100	20	4	2	10388	3727
2005	814	4921	518	1130	515	333	351	98	62	12	2	8756	3021
2006	2261	665	3949	373	751	371	245	251	70	46	9	8991	6065
2007	757	1846	527	3006	235	446	260	184	190	55	36	7544	4941
2008	2368	618	1442	355	2096	165	288	203	144	150	45	7875	4890

Table 1.5. Annual fishing mortality rate for eastern Georges Bank cod using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 ("F averaged on Age 10" method).

Year	Age Group										
	1	2	3	4	5	6	7	8	9	10	4-6
1978	*0.000*	*0.062*	*0.465*	*0.410*	*0.415*	*0.499*	*0.395*	*0.529*	*0.648*	*0.567*	*0.417*
1979	0.001	0.105	0.304	0.452	0.384	0.371	0.176	0.394	0.167	0.361	0.430
1980	0.000	0.152	0.283	0.336	0.442	0.444	0.506	0.238	0.566	0.385	0.420
1981	0.001	0.093	0.346	0.406	0.336	0.581	0.408	0.653	0.880	0.723	0.441
1982	0.001	0.234	0.399	0.682	0.726	0.883	0.805	0.832	1.005	0.862	0.711
1983	0.010	0.332	0.523	0.734	0.494	0.427	0.337	0.375	0.501	0.413	0.623
1984	0.001	0.084	0.404	0.404	0.619	0.665	0.749	0.671	0.830	0.777	0.473
1985	0.003	0.326	0.651	0.544	0.551	0.613	0.482	0.892	0.770	0.875	0.556
1986	0.001	0.103	0.460	0.640	0.556	0.484	0.314	0.370	0.609	0.443	0.562
1987	0.002	0.266	0.426	0.440	0.366	0.446	0.379	0.336	0.397	0.358	0.432
1988	0.001	0.063	0.456	0.651	0.738	0.758	0.844	0.646	0.756	0.668	0.704
1989	0.014	0.085	0.182	0.440	0.411	0.669	0.775	0.510	0.509	0.509	0.460
1990	0.002	0.291	0.543	0.433	0.583	0.472	0.610	0.301	0.631	0.447	0.506
1991	0.004	0.197	0.611	0.758	1.041	1.003	0.878	0.635	1.379	0.758	0.871
1992	0.045	0.479	0.610	0.803	1.030	0.886	0.971	0.621	0.728	0.674	0.939
1993	0.003	0.306	0.921	1.081	1.369	1.622	1.444	1.598	2.926	1.824	1.239
1994	0.001	0.079	0.621	1.194	1.270	1.128	2.032	2.474	6.732	4.217	1.209
1995	0.002	0.036	0.134	0.301	0.410	0.205	0.315	0.542	1.590	0.763	0.328
1996	0.002	0.043	0.210	0.351	0.330	0.425	0.260	0.334	0.762	0.447	0.354
1997	0.001	0.079	0.315	0.670	0.885	1.107	1.254	0.824	1.090	0.862	0.804
1998	0.000	0.038	0.330	0.542	0.838	0.989	0.874	1.677	0.512	1.216	0.746
1999	0.001	0.052	0.282	0.607	0.668	0.679	1.030	1.514	1.416	1.499	0.627
2000	0.001	0.020	0.127	0.283	0.450	0.456	0.494	0.732	0.997	0.760	0.325
2001	0.001	0.072	0.210	0.337	0.588	0.744	0.901	1.060	0.872	1.011	0.504
2002	0.002	0.012	0.111	0.259	0.270	0.476	0.435	0.610	0.705	0.640	0.295
2003	0.002	0.018	0.177	0.358	0.464	0.323	0.537	0.511	0.545	0.519	0.404
2004	0.001	0.023	0.098	0.224	0.289	0.262	0.223	0.263	0.237	0.263	0.254
2005	0.002	0.019	0.121	0.199	0.119	0.099	0.117	0.095	0.089	0.095	0.162
2006	0.002	0.030	0.068	0.244	0.300	0.140	0.076	0.064	0.014	0.029	0.246
2007	0.002	0.040	0.173	0.148	0.137	0.210	0.042	0.039	0.031	-0.012	0.155

Table 1.6. Beginning of year population biomass (thousands of mt) for eastern Georges Bank cod using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 ("F averaged on Age 10" method).

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1978	1376	1836	18395	9770	4247	1889	2073	473	294	111	2	40468	37255
1979	1175	7570	2961	15138	8165	3302	1133	1303	300	139	71	41257	32512
1980	1141	6457	11692	2864	12131	6546	2250	886	943	229	109	45248	37649
1981	2146	6278	9521	11545	2578	9179	4148	1266	750	484	175	48071	39646
1982	777	11791	9818	8827	9687	2168	5069	2571	708	281	264	51961	39393
1983	566	4272	16016	8630	5622	5515	885	2113	1201	234	133	45188	40350
1984	1673	3086	5262	12436	5214	4038	3555	589	1559	659	174	38247	33487
1985	560	9197	4871	4603	10452	3305	2050	1567	323	615	340	37883	28126
1986	2555	2982	11123	3323	3298	7151	1739	1298	861	156	288	34772	29236
1987	1053	14586	4649	9079	2924	2758	4342	947	796	194	97	41425	25786
1988	2074	5339	19343	4413	7430	1835	1629	2839	1026	615	181	46723	39310
1989	552	9273	7521	15514	2687	4486	855	531	1581	330	268	43598	33773
1990	1170	2467	15456	8728	12935	2034	2512	403	451	991	283	47430	43793
1991	761	3995	3743	12630	6783	6632	1306	1308	256	226	486	38126	33370
1992	300	5786	5799	2453	6413	2724	2676	506	559	0	137	27354	21268
1993	235	1825	6585	3890	1389	2599	1053	934	240	187	48	18985	16924
1994	137	1804	1629	3098	1476	496	557	261	185	21	64	9728	7787
1995	228	1378	3196	1071	955	426	109	61	25	0	0	7451	5844
1996	109	835	2161	3796	1229	962	315	124	44	5	0	9580	8636
1997	418	1417	1454	1999	2727	1158	568	405	62	23	3	10233	8398
1998	129	1877	1917	1147	1191	1340	283	165	106	14	8	8177	6171
1999	643	1391	3224	1906	735	635	610	184	25	107	6	9467	7432
2000	0	3052	1673	3432	1218	476	369	213	35	8	16	10492	7441
2001	18	1206	3782	1847	3302	1045	371	212	104	9	3	11898	10674
2002	0	612	1575	4130	1573	1843	468	150	80	41	4	10477	9865
2003	0	342	1206	1752	3482	941	1107	281	60	0	21	9192	8850
2004	94	148	2220	1860	2037	2438	716	675	206	33	22	10448	10207
2005	9	2954	611	1921	1495	1124	1390	676	398	56	30	10663	7700
2006	73	209	4519	542	1917	1183	1077	1158	404	316	53	11450	11168
2007	41	1011	551	5601	609	1906	1596	1285	1520	410	218	14749	13697
2008	101	369	2126	750	5355	604	1212	1610	1447	1183	271	15029	14559

Table 1.7. Projection output from ADAPT for the method averaging F on Age 10.

F averaged on 10, using a 2 year average from the assessment for the PR

	Age Group										
	1	2	3	4	5	6	7	8	9	10	11
Natural Mortality											
2007-2008	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Fishery Partial Recruitment											
2007-2008	0.01	0.20	0.70	1	1	1	0.30	0.30	0.10	0.05	0.05
Fishery Weight at Age											
2007-2008	0.28	0.90	1.61	2.40	3.31	4.24	5.76	6.47	7.24	8.48	11.64
Population Beginning of Year Weight at Age											
2009-2010	0.04	0.49	1.22	1.81	2.56	3.71	4.91	6.51	7.92	7.40	8.35

	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
Projected Population Numbers													
2009	2368	1934	491	995	228	1350	108	221	152	114	122		
2010	2368	1935	1527	354	681	156	923	84	171	122	93		
Fishing Mortality													
2008	0.002	0.049	0.173	0.247	0.247	0.247	0.074	0.074	0.025	0.012	0.012		
2009	0.002	0.036	0.126	0.18	0.18	0.18	0.054	0.054	0.018	0.009	0.009		
Projected Population Biomass													
2009	95	948	599	1801	584	5009	529	1437	1202	847	1020	14071	13028
2010	95	948	1863	641	1742	579	4534	544	1356	903	776	13981	12938
Projected Catch Numbers													
2008	5	28	208	71	420	33	19	13	3	2	0		
2009	4	62	53	149	34	202	5	11	2	1	1		
Projected Catch Biomass													
2008	1	25	336	170	1391	142	108	84	23	14	6	2300	
2009	1	56	85	357	113	858	30	68	18	8	12	1605	

Table 1.8. Beginning of year population abundance (numbers in thousands) for eastern Georges Bank cod using a weighted average of F on age 8 and 9 for calculating the F on Age 10 for 1978 to 2000, and a weighted average of F on ages 6 and 7 for calculating F on Age 6 for 1997 to 2005 ("F averaged on Age 10 and 6" method)

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1978	11131	2210	10563	3506	991	307	279	56	26	9	0	29078	15737
1979	9504	9112	1700	5432	1905	536	152	154	27	11	4	28538	9922
1980	9231	7772	6714	1028	2830	1062	303	105	85	19	6	29154	12151
1981	17355	7557	5467	4143	601	1490	558	149	68	39	10	37438	12526
1982	6287	14192	5638	3167	2260	352	682	304	64	23	16	32984	12505
1983	4581	5142	9196	3097	1312	895	119	250	108	19	8	24727	15004
1984	13532	3715	3022	4462	1216	655	478	70	140	54	10	27355	10108
1985	4532	11070	2797	1652	2438	536	276	185	29	50	20	23585	7984
1986	21113	3699	6543	1194	785	1150	238	139	62	11	17	34952	10140
1987	7023	17260	2733	3381	515	368	581	142	79	28	6	32115	7832
1988	13625	5737	10835	1461	1782	293	193	325	83	43	16	34395	15032
1989	3880	11147	4411	5624	624	697	112	68	140	32	18	26753	11726
1990	5451	3132	8386	3011	2965	339	292	42	33	69	16	23737	15154
1991	8671	4455	1918	3988	1599	1355	173	130	26	15	36	22365	9239
1992	2649	7069	2995	853	1530	462	407	59	56	5	6	16091	6373
1993	3708	2081	3586	1333	313	447	156	126	26	22	2	11800	6011
1994	2263	3029	1291	1169	370	65	72	30	21	1	3	8315	3023
1995	1510	1850	2311	620	290	85	17	8	2	0	0	6693	3332
1996	2729	1235	1464	1680	399	157	57	10	4	0	0	7735	3771
1997	4316	2230	973	984	1016	256	84	36	6	1	0	9902	3356
1998	1526	3531	1703	605	437	420	110	20	13	2	0	8365	3308
1999	4169	1248	2798	1052	318	178	194	66	3	6	0	10033	4615
2000	2000	3411	965	1804	534	161	90	112	43	1	1	9123	3713
2001	2083	1636	2739	686	1175	321	101	56	81	34	0	8912	5192
2002	2785	1704	1237	1818	381	625	175	56	30	61	27	8901	4411
2003	837	2277	1380	895	1149	224	381	120	39	22	49	7372	4259
2004	6294	683	1836	970	485	588	118	238	84	29	16	11341	4364
2005	839	5151	547	1383	657	277	365	67	175	65	23	9549	3559
2006	2380	685	4137	397	959	487	198	263	45	139	52	9743	6677
2007	780	1943	543	3161	255	616	355	146	200	35	112	8146	5423
2008	2368	637	1522	369	2223	181	427	281	113	158	28	8307	5302

Table 1.9. Annual fishing mortality rate for eastern Georges Bank cod using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 for 1978 to 2000, and a weighted average of F on ages 6 and 7 for calculating F on Age 6 for 1997 to 2005 ("F averaged on Age 10 and 6" method).

Year	Age Group										
	1	2	3	4	5	6	7	8	9	10	4-6
1978	0.000	0.062	0.465	0.410	0.415	0.499	0.395	0.529	0.648	0.567	0.417
1979	0.001	0.105	0.304	0.452	0.384	0.371	0.176	0.394	0.167	0.361	0.430
1980	0.000	0.152	0.283	0.336	0.442	0.444	0.506	0.238	0.566	0.385	0.420
1981	0.001	0.093	0.346	0.406	0.336	0.581	0.408	0.653	0.880	0.723	0.441
1982	0.001	0.234	0.399	0.682	0.726	0.883	0.805	0.832	1.005	0.862	0.711
1983	0.010	0.332	0.523	0.734	0.494	0.427	0.337	0.375	0.501	0.413	0.623
1984	0.001	0.084	0.404	0.404	0.619	0.665	0.749	0.671	0.830	0.777	0.473
1985	0.003	0.326	0.651	0.544	0.551	0.613	0.482	0.892	0.770	0.875	0.556
1986	0.001	0.103	0.460	0.640	0.556	0.484	0.314	0.370	0.609	0.443	0.562
1987	0.002	0.266	0.426	0.440	0.366	0.446	0.379	0.336	0.397	0.358	0.432
1988	0.001	0.063	0.456	0.651	0.738	0.758	0.844	0.646	0.756	0.668	0.704
1989	0.014	0.085	0.182	0.440	0.411	0.669	0.775	0.510	0.509	0.509	0.460
1990	0.002	0.291	0.543	0.433	0.583	0.472	0.610	0.301	0.631	0.447	0.506
1991	0.004	0.197	0.611	0.758	1.041	1.003	0.878	0.635	1.379	0.758	0.871
1992	0.041	0.479	0.610	0.803	1.030	0.886	0.971	0.621	0.728	0.674	0.939
1993	0.002	0.277	0.921	1.081	1.370	1.622	1.444	1.598	2.926	1.824	1.240
1994	0.001	0.071	0.534	1.195	1.272	1.129	2.033	2.475	6.733	4.218	1.210
1995	0.001	0.034	0.119	0.239	0.411	0.206	0.316	0.543	1.592	0.764	0.287
1996	0.002	0.038	0.197	0.303	0.244	0.426	0.261	0.335	0.764	0.448	0.301
1997	0.001	0.070	0.276	0.611	0.684	0.648	1.259	0.829	1.097	0.867	0.648
1998	0.000	0.033	0.282	0.444	0.698	0.571	0.305	1.710	0.518	1.239	0.556
1999	0.001	0.057	0.239	0.477	0.478	0.477	0.349	0.225	1.550	1.550	0.477
2000	0.001	0.019	0.142	0.229	0.309	0.269	0.281	0.128	0.046	1.000	0.249
2001	0.001	0.079	0.210	0.388	0.431	0.409	0.384	0.409	0.077	0.018	0.414
2002	0.002	0.011	0.123	0.259	0.332	0.295	0.178	0.158	0.146	0.028	0.277
2003	0.002	0.015	0.153	0.413	0.470	0.442	0.269	0.158	0.090	0.065	0.445
2004	0.001	0.022	0.083	0.190	0.361	0.275	0.366	0.108	0.059	0.031	0.255
2005	0.002	0.019	0.120	0.166	0.099	0.133	0.128	0.197	0.033	0.023	0.143
2006	0.003	0.032	0.069	0.244	0.243	0.116	0.106	0.073	0.061	0.011	0.210
2007	0.003	0.044	0.187	0.152	0.140	0.167	0.035	0.057	0.037	0.015	0.154

Table 1.10. Beginning of year population biomass (thousands of mt) for eastern Georges Bank cod using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 for 1978 to 2000, and a weighted average of F on ages 6 and 7 for calculating F on Age 6 for 1997 to 2005 ("F averaged on Age 10 and 6" method).

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1978	1376	1836	18395	9770	4247	1889	2073	473	294	111	2	40468	37255
1979	1175	7570	2961	15138	8165	3302	1133	1303	300	139	71	41257	32512
1980	1141	6457	11692	2864	12131	6546	2250	886	943	229	109	45248	37649
1981	2146	6278	9521	11545	2578	9179	4148	1266	750	484	175	48071	39646
1982	777	11791	9818	8827	9687	2168	5069	2571	708	281	264	51961	39393
1983	566	4272	16016	8630	5622	5515	885	2113	1201	234	133	45188	40350
1984	1673	3086	5262	12436	5214	4038	3555	589	1559	659	174	38247	33487
1985	560	9197	4871	4603	10452	3305	2050	1567	323	615	340	37883	28126
1986	2555	2982	11123	3323	3298	7151	1739	1298	861	156	288	34772	29236
1987	1053	14586	4649	9079	2924	2758	4342	947	796	194	97	41425	25786
1988	2074	5339	19343	4413	7430	1835	1629	2839	1026	615	181	46723	39310
1989	552	9273	7521	15514	2687	4486	855	531	1581	330	268	43598	33773
1990	1170	2466	15456	8728	12935	2034	2512	403	451	991	283	47430	43793
1991	761	3995	3743	12630	6783	6632	1306	1308	256	226	486	38126	33370
1992	326	5786	5798	2453	6413	2724	2676	506	559	0	137	27378	21267
1993	260	1986	6584	3889	1388	2599	1053	934	240	187	48	19169	16922
1994	145	1998	1824	3097	1475	495	557	261	185	21	64	10123	7979
1995	255	1452	3569	1308	954	425	109	61	25	0	0	8158	6452
1996	124	933	2280	4302	1596	961	314	124	44	5	0	10682	9625
1997	481	1607	1632	2136	3242	1637	567	403	61	23	3	11794	9705
1998	119	2161	2196	1340	1349	1948	633	164	105	14	8	10037	7757
1999	650	1284	3732	2292	946	827	1345	729	24	105	6	11943	10008
2000	0	3088	1537	4148	1668	742	589	928	499	7	15	13222	10134
2001	21	1119	3827	1676	4216	1651	697	418	828	334	2	14789	13649
2002	0	722	1454	4191	1368	2760	1039	475	304	725	430	13467	12745
2003	0	410	1425	1600	3549	779	1996	815	301	0	699	11573	11163
2004	99	156	2670	2265	1783	2514	541	1614	882	265	236	13025	12771
2005	9	3092	645	2352	1907	933	1448	462	1129	298	301	12576	9475
2006	77	215	4734	576	2447	1553	873	1213	258	957	316	13220	12928
2007	42	1065	569	5888	659	2632	2179	1020	1598	257	676	16584	15478
2008	101	380	2243	779	5677	662	1797	2228	1135	1247	168	16419	15937

Table 1.11. Projection output from ADAPT for the method averaging F on Age 10.

F averaged on 10 and 6

	Age Group												
	1	2	3	4	5	6	7	8	9	10	11		
Natural Mortality													
2007-2008	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
Fishery Partial Recruitment													
2007-2008	0.01	0.15	0.6	1	1	1	0.7	0.4	0.25	0.1	0.1		
Fishery Weight at Age													
2007-2008	0.28	0.90	1.61	2.40	3.31	4.24	5.76	6.47	7.24	8.48	11.64		
Population Beginning of Year Weight at Age													
2009-2010	0.04	0.49	1.22	1.81	2.56	3.71	4.91	6.51	7.92	7.40	8.35		

	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
Projected Population Numbers													
2009	2368	1935	506	1101	246	1481	121	302	212	88	127		
2010	2368	1935	1542	372	753	168	1013	87	230	166	71		
Fishing Mortality													
2008	0.002	0.031	0.124	0.206	0.206	0.206	0.144	0.082	0.051	0.021	0.021		
2009	0.002	0.027	0.108	0.18	0.18	0.18	0.126	0.072	0.045	0.018	0.018		
Projected Population Biomass													
2009	95	948	617	1994	630	5495	593	1969	1678	650	1058	15726	14683
2010	95	948	1881	672	1928	624	4974	567	1825	1227	590	15332	14289
Projected Catch Numbers													
2008	4	18	161	62	376	31	52	20	5	3	1		
2009	4	47	47	165	37	222	13	19	8	1	2		
Projected Catch Biomass													
2008	1	16	259	150	1246	130	299	130	37	25	6	2300	
2009	1	42	76	395	122	942	75	123	61	12	24	1873	

Table 1.12. Beginning of year population abundance (numbers in thousands) for eastern Georges Bank cod using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 and splitting the indices between 1994 and 1995 ("F Averaged on Age 10 with Indices Split" method).

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1978	11131	2210	10563	3506	991	307	279	56	26	9	0	29078	15737
1979	9504	9112	1700	5432	1905	536	152	154	27	11	4	28538	9922
1980	9231	7772	6714	1028	2830	1062	303	105	85	19	6	29154	12151
1981	17355	7557	5467	4143	601	1490	558	149	68	39	10	37438	12526
1982	6287	14192	5638	3167	2260	352	682	304	64	23	16	32984	12505
1983	4581	5142	9196	3097	1312	895	119	250	108	19	8	24727	15004
1984	13532	3715	3022	4462	1216	655	478	70	140	54	10	27355	10108
1985	4532	11070	2797	1652	2438	536	276	185	29	50	20	23585	7984
1986	21113	3699	6543	1194	785	1150	238	139	62	11	17	34952	10140
1987	7023	17260	2733	3381	515	368	581	142	79	28	6	32115	7832
1988	13625	5737	10835	1461	1782	293	193	325	83	43	16	34395	15032
1989	3880	11147	4411	5624	624	697	112	68	140	32	18	26753	11726
1990	5452	3132	8386	3011	2965	339	292	42	33	69	16	23738	15154
1991	8672	4455	1918	3988	1599	1355	173	130	26	15	36	22366	9239
1992	2442	7070	2996	853	1530	462	407	59	56	5	6	15886	6374
1993	3344	1912	3587	1333	313	447	156	126	26	22	2	11268	6012
1994	2141	2731	1153	1169	370	65	72	30	21	1	3	7757	2885
1995	1339	1751	2067	507	290	85	17	8	2	0	0	6066	2976
1996	2345	1095	1382	1480	307	157	57	10	4	0	0	6838	3398
1997	3535	1916	859	917	852	181	84	36	6	1	0	8388	2936
1998	1334	2892	1446	511	383	287	49	20	13	2	0	6936	2710
1999	3367	1091	2274	842	241	134	87	17	3	6	0	8062	3604
2000	1680	2754	837	1376	363	99	55	25	3	1	1	7193	2759
2001	1231	1374	2201	581	825	181	50	27	9	1	0	6479	3875
2002	1730	1006	1023	1378	295	340	61	15	7	3	0	5857	3121
2003	553	1413	809	720	789	154	148	27	5	2	1	4621	2655
2004	4194	451	1128	502	342	295	61	48	8	2	1	7031	2386
2005	631	3431	357	804	274	160	126	20	20	3	1	5828	1765
2006	2054	515	2729	242	485	174	103	68	7	12	1	6390	3820
2007	847	1677	404	2008	128	229	99	68	40	4	8	5511	2987
2008	2368	692	1304	255	1279	77	110	71	49	27	3	6235	3176

Table 1.13. Annual fishing mortality rate for eastern Georges Bank cod using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 and splitting the indices between 1994 and 1995 ("F Averaged on Age 10 with Indices Split" method).

Year	Age Group										
	1	2	3	4	5	6	7	8	9	10	4-6
1978	0.000	0.062	0.465	0.410	0.415	0.499	0.395	0.529	0.648	0.567	0.417
1979	0.001	0.105	0.304	0.452	0.384	0.371	0.176	0.394	0.167	0.361	0.430
1980	0.000	0.152	0.283	0.336	0.442	0.444	0.506	0.238	0.566	0.385	0.420
1981	0.001	0.093	0.346	0.406	0.336	0.581	0.408	0.653	0.880	0.723	0.441
1982	0.001	0.234	0.399	0.682	0.726	0.883	0.805	0.832	1.005	0.862	0.711
1983	0.010	0.332	0.523	0.734	0.494	0.427	0.337	0.375	0.501	0.413	0.623
1984	0.001	0.084	0.404	0.404	0.619	0.665	0.749	0.671	0.830	0.777	0.473
1985	0.003	0.326	0.651	0.544	0.551	0.613	0.482	0.892	0.770	0.875	0.556
1986	0.001	0.103	0.460	0.640	0.556	0.484	0.314	0.370	0.609	0.443	0.562
1987	0.002	0.266	0.426	0.440	0.366	0.446	0.379	0.336	0.397	0.358	0.432
1988	0.001	0.063	0.456	0.651	0.738	0.758	0.844	0.646	0.756	0.668	0.704
1989	0.014	0.085	0.182	0.440	0.411	0.669	0.775	0.510	0.509	0.509	0.460
1990	0.002	0.291	0.543	0.433	0.583	0.472	0.610	0.301	0.631	0.447	0.506
1991	0.004	0.197	0.611	0.758	1.041	1.003	0.878	0.635	1.379	0.758	0.871
1992	0.045	0.479	0.610	0.803	1.030	0.886	0.971	0.621	0.728	0.674	0.939
1993	0.003	0.306	0.921	1.081	1.369	1.622	1.444	1.598	2.926	1.824	1.240
1994	0.001	0.079	0.621	1.194	1.271	1.128	2.032	2.475	6.732	4.217	1.209
1995	0.002	0.036	0.134	0.301	0.411	0.206	0.315	0.542	1.590	0.764	0.328
1996	0.002	0.043	0.210	0.352	0.330	0.426	0.260	0.334	0.763	0.447	0.354
1997	0.001	0.082	0.319	0.674	0.887	1.109	1.255	0.826	1.092	0.864	0.808
1998	0.001	0.040	0.341	0.552	0.849	0.997	0.877	1.684	0.514	1.222	0.756
1999	0.001	0.066	0.302	0.640	0.690	0.698	1.053	1.533	1.441	1.519	0.656
2000	0.001	0.024	0.165	0.312	0.494	0.483	0.518	0.771	1.038	0.799	0.357
2001	0.002	0.094	0.267	0.477	0.685	0.892	1.014	1.189	0.984	1.135	0.633
2002	0.002	0.018	0.150	0.355	0.452	0.629	0.623	0.796	0.952	0.845	0.416
2003	0.004	0.025	0.272	0.536	0.770	0.728	0.907	1.033	0.940	1.017	0.665
2004	0.001	0.033	0.137	0.393	0.535	0.606	0.885	0.655	0.925	0.693	0.491
2005	0.003	0.027	0.185	0.300	0.242	0.220	0.353	0.836	0.298	0.836	0.277
2006	0.003	0.040	0.101	0.415	0.530	0.327	0.184	0.182	0.411	0.109	0.460
2007	0.002	0.046	0.239	0.231	0.269	0.470	0.108	0.099	-0.154	0.108	0.256

Table 1.14. Beginning of year population biomass (thousands of mt) for eastern Georges Bank cod using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 and splitting the indices between 1994 and 1995 ("F Averaged on Age 10 with Indices Split" method).

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1978	1376	1836	18395	9770	4247	1889	2073	473	294	111	2	40468	37255
1979	1175	7570	2961	15138	8165	3302	1133	1303	300	139	71	41257	32512
1980	1141	6457	11692	2864	12131	6546	2250	886	943	229	109	45248	37649
1981	2146	6278	9521	11545	2578	9179	4148	1266	750	484	175	48071	39646
1982	777	11791	9818	8827	9687	2168	5069	2571	708	281	264	51961	39393
1983	566	4272	16016	8630	5622	5515	885	2113	1201	234	133	45188	40350
1984	1673	3086	5262	12436	5214	4038	3555	589	1559	659	174	38247	33487
1985	560	9197	4871	4603	10452	3305	2050	1567	323	615	340	37883	28126
1986	2555	2982	11123	3323	3298	7151	1739	1298	861	156	288	34772	29236
1987	1053	14586	4649	9079	2924	2758	4342	947	796	194	97	41425	25786
1988	2074	5339	19343	4413	7430	1835	1629	2839	1026	615	181	46723	39310
1989	552	9273	7521	15514	2687	4486	855	531	1581	330	268	43598	33773
1990	1170	2467	15456	8728	12935	2034	2512	403	451	991	283	47430	43793
1991	761	3995	3743	12630	6783	6632	1306	1308	256	226	486	38126	33370
1992	300	5786	5799	2453	6413	2724	2676	506	559	0	137	27354	21268
1993	235	1825	6584	3889	1389	2599	1053	934	240	187	48	18983	16924
1994	137	1802	1629	3097	1476	496	557	261	185	21	64	9725	7786
1995	226	1374	3192	1071	955	426	109	61	25	0	0	7439	5839
1996	107	827	2153	3791	1228	962	315	124	44	5	0	9555	8621
1997	394	1381	1440	1991	2721	1157	568	404	61	23	3	10143	8368
1998	104	1770	1865	1132	1181	1334	282	165	105	14	8	7960	6086
1999	525	1123	3034	1834	718	623	602	183	25	106	6	8780	7132
2000	0	2493	1332	3164	1134	455	356	205	34	8	16	9197	6705
2001	12	940	3075	1419	2960	932	345	199	96	8	3	9991	9038
2002	0	426	1202	3177	1060	1501	362	125	66	34	4	7956	7530
2003	0	254	835	1286	2437	535	777	182	42	0	14	6363	6108
2004	66	103	1641	1173	1256	1261	279	328	82	16	9	6214	6045
2005	7	2060	421	1367	797	539	500	141	129	12	9	5981	3914
2006	66	162	3123	351	1238	555	452	311	40	80	5	6384	6156
2007	46	919	423	3741	330	978	608	473	320	27	50	7914	6950
2008	101	413	1922	539	3268	283	464	565	491	212	15	8272	7758

Table 1.15. Projection output from ADAPT using a weighted average of F on Age 8 and 9 for calculating the F on Age 10 and splitting the indices between 1994 and 1995 ("F averaged on Age 10 with Indices Split" method).

F averaged on 10. Indices split

	Age Group												
	1	2	3	4	5	6	7	8	9	10	11		
Natural Mortality													
2007-2008	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2		
Fishery Partial Recruitment													
2007-2008	0.010	0.100	0.500	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000		
Fishery Weight at Age													
2007-2008	0.28	0.90	1.61	2.40	3.31	4.24	5.76	6.47	7.24	8.48	11.64		
Population Beginning of Year Weight at Age													
2009-2010	0.04	0.49	1.22	1.81	2.56	3.71	4.91	6.51	7.92	7.40	8.35		
	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
Projected Population Numbers													
2009	2368	1932	546	886	144	722	44	62	40	28	15		
2010	2368	1935	1553	408	606	98	494	30	43	27	19		
Fishing Mortality													
2008	2008	0.004	0.037	0.186	0.372	0.372	0.372	0.372	0.372	0.372	0.372	0.372	
2009	2009	0.002	0.018	0.09	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	
Projected Population Biomass													
2009	95	946	666	1604	369	2678	214	405	318	204	126	7625	6584
2010	95	948	1895	739	1551	365	2424	194	337	203	157	8909	7866
Projected Catch Numbers													
2008	8	23	201	72	363	22	31	20	14	8	1		
2009	4	31	43	133	22	108	7	9	6	4	2		
Projected Catch Biomass													
2008	2	21	325	174	1202	93	180	131	100	64	8	2300	
2009	1	28	69	318	71	459	38	60	44	35	26	1149	

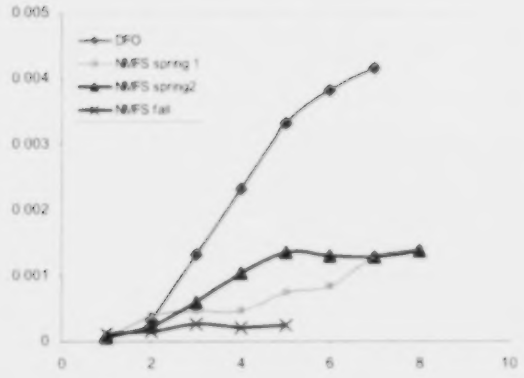

Figure 1.1. Survey catchabilities (q) by age from the "Age Extended" model formulation

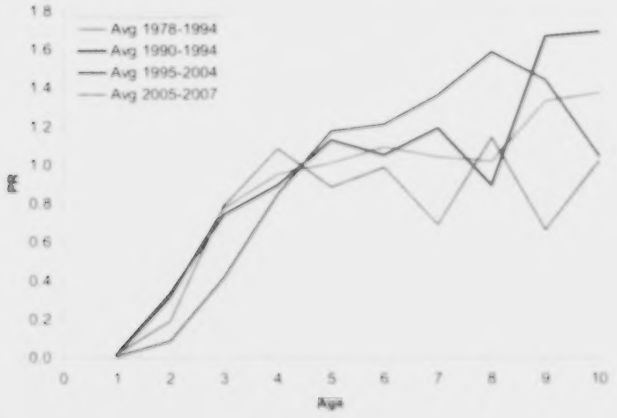

Figure 1.2. Fishery partial recruitment by age from the "Age Extended" model formulation.

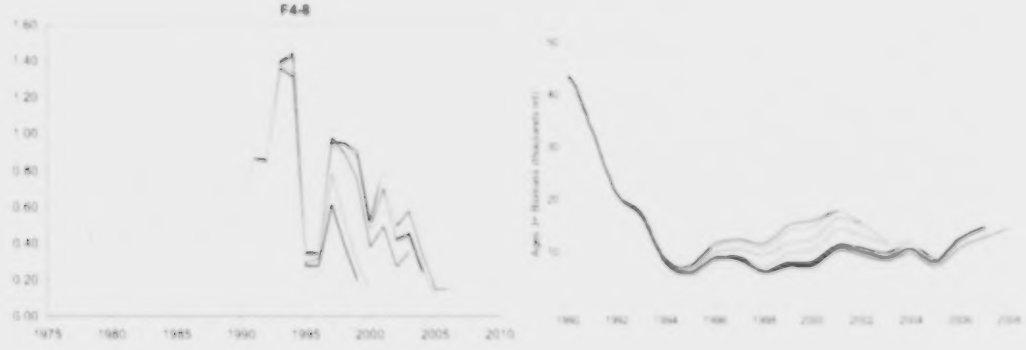

Figure 1.3. Retrospective pattern for F and 3+ biomass, "Age Extended" model formulation.

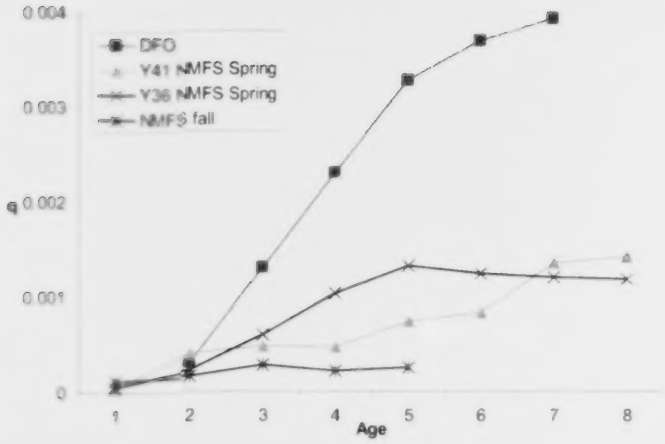

Figure 1.4. Survey catchabilities (q) by age from the "F Averaged on Age 10" model formulation

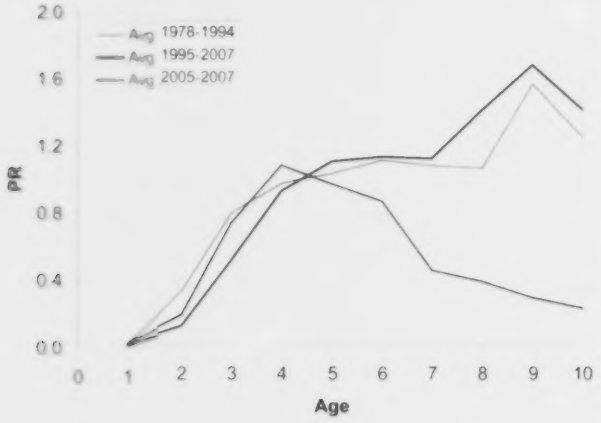

Figure 1.5. Fishery partial recruitment by age from the "F Averaged on Age 10" model formulation.

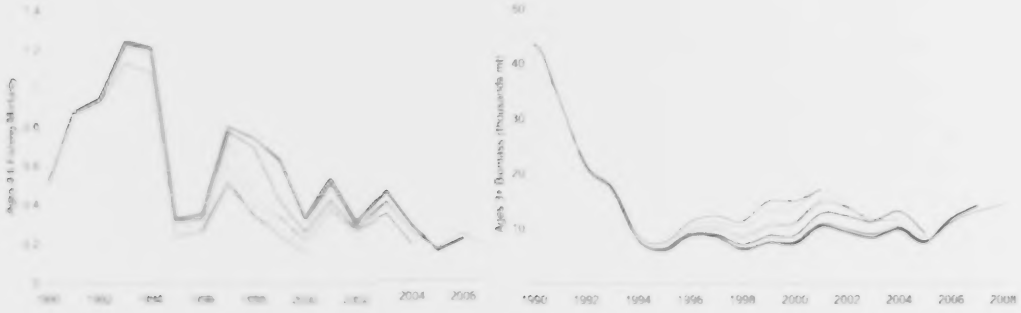

Figure 1.6. Retrospective pattern for F and 3+ biomass, "F Averaged on Age 10" model formulation.

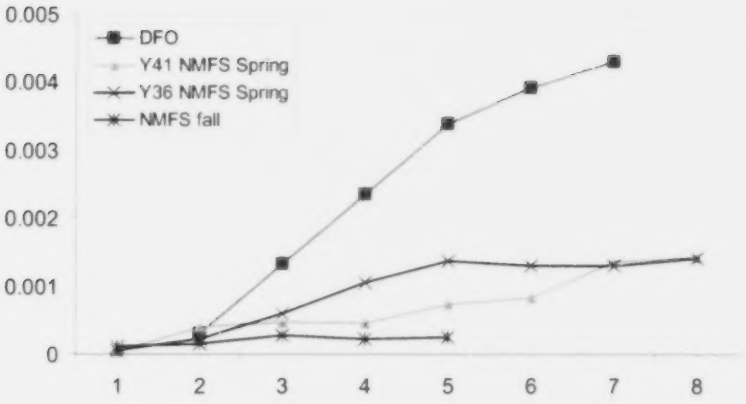

Figure 1.7. Survey catchabilities (q) by age from the "F Averaged on Age 10 and 6" model formulation

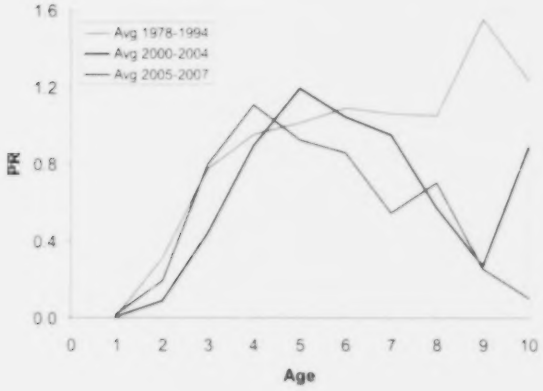

Figure 1.8. Fishery partial recruitment by age from the "F Averaged on Age 10 and 6" model formulation.

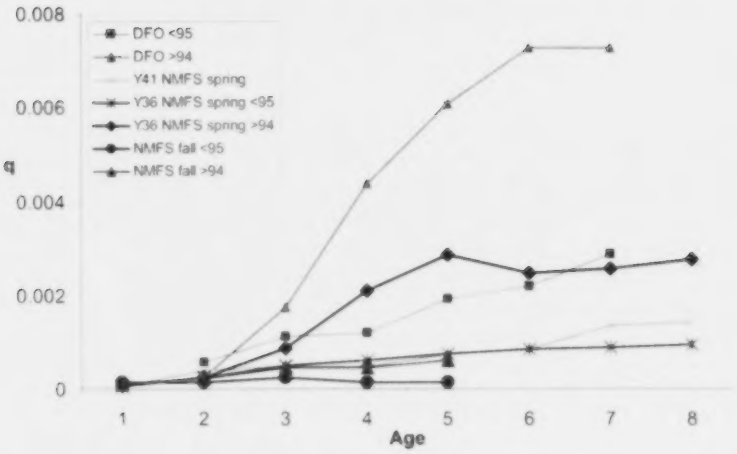

Figure 1.9. Survey catchabilities (q) by age from the "F Averaged on Age 10 with Split Indices" model formulation.

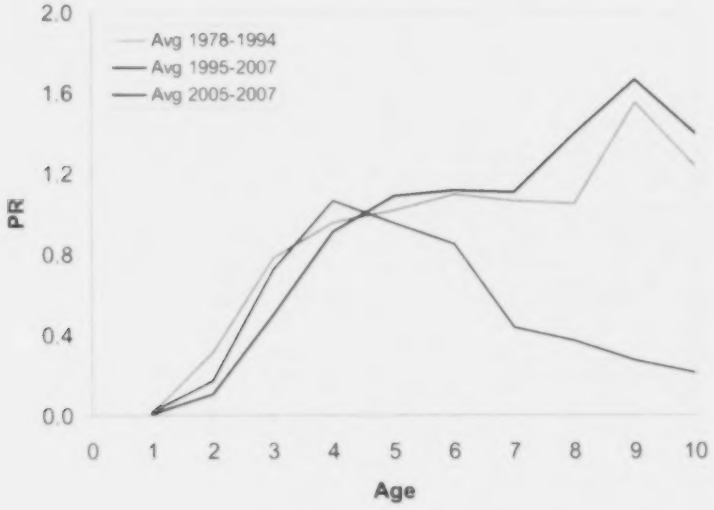

Figure 1.10. Fishery partial recruitment by age from the "F Averaged on Age 10 with Split Index" model formulation.

APPENDIX 2:

Corrections to Tables for Catch at Age, Weight at Age, Beginning of Year Population Abundance, Annual Fishing Mortality Rate, Beginning of Year Population Biomass, Projection Inputs, Deterministic Projection Results, and Risk Plot.

After the completion, presentation and review of the 2008 assessment for 5Zjm cod, an error in the 2004 catch at age was noticed. This was corrected and the VPA was rerun. The updated catch at age led very slight changes in the VPA output and projections and did not change the outlook for the stock.

In the interests of completeness, the updated tables and risk plot using the correct catch at age for 2004 are included in this appendix (Table 2.1 to 2.7, Figure 2.1).

Table 2.1. Annual catch at age numbers (thousands) for eastern Georges Bank cod (update of Table 5 in the document).

Year	Age Group										
	1	2	3	4	5	6	7	8	9	10	1+
1978	2.0	121.0	3588.0	1076.0	307.0	110.0	83.0	21.0	11.6	3.6	5327
1979	10.2	827.6	405.7	1803.7	554.1	151.5	22.4	45.8	3.8	3.1	3829
1980	1.0	994.3	1506.1	267.0	922.8	347.6	109.8	20.1	33.6	5.4	4212
1981	19.2	609.0	1457.3	1261.3	156.5	600.9	170.7	65.6	36.4	18.6	4396
1982	6.0	2692.7	1692.7	1434.7	1070.2	189.8	346.4	157.6	37.2	12.2	7665
1983	40.1	1322.4	3424.7	1477.8	467.2	283.7	31.1	71.2	38.9	5.9	7173
1984	10.1	270.6	916.5	1354.2	514.1	291.8	231.4	31.2	72.8	26.6	3744
1985	12.1	2804.8	1226.6	633.9	945.3	225.0	96.4	100.5	14.4	26.9	6095
1986	28.2	328.5	2204.8	516.9	306.3	403.1	58.4	39.3	25.9	3.6	3925
1987	14.0	3665.8	864.9	1098.9	144.0	121.0	167.0	37.0	23.6	7.6	6147
1988	9.9	317.3	3621.9	640.5	853.7	142.8	101.1	141.8	40.5	19.4	5906
1989	48.8	820.1	667.0	1827.6	191.8	311.7	55.6	24.8	50.9	11.7	4021
1990	9.0	719.5	3215.2	965.9	1199.1	116.4	122.3	10.0	14.3	22.6	6403
1991	33.3	724.1	802.4	1944.5	953.3	790.4	93.0	56.0	17.8	7.1	5434
1992	96.9	2456.9	1252.0	432.1	906.9	249.8	232.8	25.0	26.8	2.4	5686
1993	7.6	458.9	1986.2	812.3	216.1	333.7	110.6	93.6	23.2	17.4	4062
1994	2.9	187.5	488.5	753.0	246.5	40.7	58.8	26.0	20.3	1.1	1826
1995	2.0	56.5	235.2	120.1	89.1	14.4	4.2	3.0	1.5	0.0	526
1996	4.4	41.7	238.5	400.3	78.8	49.8	11.8	2.7	1.8	0.1	830
1997	3.0	136.2	213.7	412.0	461.1	111.8	55.7	18.5	3.7	0.7	1417
1998	0.6	103.2	381.1	198.1	201.2	167.0	26.2	14.9	4.7	1.1	1100
1999	3.3	63.0	540.4	364.4	110.1	61.7	52.1	12.1	2.1	4.6	1214
2000	1.8	59.6	115.8	335.9	129.5	34.6	20.2	12.2	1.8	0.3	712
2001	1.9	112.9	471.5	201.2	375.3	98.4	29.3	17.1	5.4	0.5	1314
2002	3.9	16.5	130.5	377.6	98.0	145.7	25.8	7.5	3.8	1.5	811
2003	1.8	31.6	177.9	276.5	393.6	73.0	81.9	15.9	3.1	1.2	1057
2004	2.8	9.0	125.7	154.5	144.3	137.8	36.8	29.2	7.2	1.5	650
2005	1.7	88.4	56.3	192.8	56.3	31.3	39.8	10.9	5.2	1.3	484
2006	5.8	19.6	251.2	78.3	188.1	48.3	18.2	16.9	2.4	1.3	631
2007	2.1	76.3	84.1	404.9	30.3	85.9	11.0	7.4	6.6	0.5	709

Table 2.2. Average fishery weights at age (kg) of cod from eastern Georges Bank (update of Table 6 in the document).

Year	Age Group									
	1	2	3	4	5	6	7	8	9	10
1978	0.71	1.31	2.46	3.47	4.34	5.79	7.37	8.49	11.79	13.62
1979	0.89	1.49	2.15	4.21	4.89	7.18	9.18	10.31	11.70	14.06
1980	0.84	1.46	2.47	3.67	5.65	6.68	8.39	9.09	8.43	14.35
1981	0.88	1.50	2.36	3.42	5.21	7.22	8.57	9.89	14.17	13.57
1982	0.77	1.40	2.66	3.83	5.35	6.51	9.36	9.90	12.50	13.68
1983	0.97	1.49	2.38	3.31	4.64	6.39	7.96	10.29	11.23	12.21
1984	1.05	1.64	2.45	3.62	5.08	6.58	8.91	10.10	11.30	13.79
1985	0.91	1.42	2.09	3.89	5.09	6.41	8.10	10.24	11.42	12.72
1986	0.93	1.48	2.45	3.66	5.60	7.19	8.92	9.96	12.69	8.91
1987	0.73	1.48	2.50	4.19	5.81	7.73	8.95	10.01	11.41	13.93
1988	0.79	1.52	2.36	3.51	5.40	6.65	8.78	9.99	11.14	13.17
1989	0.81	1.62	2.27	3.77	5.40	6.69	8.22	10.72	11.67	14.14
1990	0.83	1.56	2.46	3.52	4.89	6.33	8.46	10.65	12.58	14.04
1991	1.11	1.63	2.55	3.42	4.77	5.89	7.41	10.52	9.69	14.52
1992	1.15	1.54	2.46	3.84	4.70	6.16	7.51	9.85	12.06	14.52
1993	0.88	1.57	2.31	3.08	4.50	5.73	7.08	8.88	9.70	10.86
1994	0.91	1.46	2.41	3.83	4.80	7.09	7.86	8.93	9.70	10.37
1995	0.90	1.49	2.51	3.72	5.22	6.52	11.06	10.12	10.38	14.52
1996	1.03	1.54	2.36	3.34	5.24	6.36	6.92	8.46	12.88	10.51
1997	0.98	1.50	2.23	3.34	4.25	5.80	8.05	8.33	11.87	14.52
1998	0.63	1.48	2.37	3.19	4.27	5.83	6.99	8.30	12.68	11.81
1999	0.80	1.55	2.29	3.53	4.16	6.31	6.78	8.04	12.15	13.54
2000	0.87	1.46	2.13	3.08	4.23	4.92	6.20	7.34	8.27	12.97
2001	0.88	1.49	2.33	3.00	4.05	5.12	5.08	8.02	9.22	14.81
2002	0.55	1.42	2.27	3.08	4.30	5.07	6.75	8.28	8.82	8.46
2003	0.26	1.66	2.15	2.67	3.68	4.35	5.67	7.29	7.86	9.02
2004	0.70	1.36	2.01	2.83	3.39	4.56	5.52	7.35	9.04	8.86
2005	0.17	0.91	1.53	2.43	3.50	4.50	4.87	6.80	7.98	8.69
2006	0.19	0.69	1.74	2.35	3.37	4.26	6.12	5.80	6.87	7.43
2007	0.48	1.09	1.57	2.41	3.07	3.97	6.28	6.80	6.88	9.30
Min.	0.17	0.69	1.53	2.35	3.07	3.97	4.87	5.80	6.87	7.43
Max.	1.15	1.66	2.66	4.21	5.81	7.73	11.06	10.72	14.17	14.81
Avg.[1]	0.36	1.14	1.80	2.55	3.42	4.33	5.69	6.81	7.72	8.66

[1]for 2003-2007

Table 2.3. Beginning of year population abundance (numbers in thousands) for eastern Georges Bank cod using the "Around the Corner" benchmark model formulation (update of Table 13 in the document)

Year	Age Group											
	1	2	3	4	5	6	7	8	9	10	11	1+
1978	11131	2210	10563	3506	991	307	279	56	26	9	0	29078
1979	9504	9112	1700	5432	1905	536	152	154	27	11	4	28538
1980	9231	7772	6714	1028	2830	1062	303	105	85	19	6	29154
1981	17355	7557	5467	4143	601	1490	558	149	68	39	10	37438
1982	6287	14192	5638	3167	2260	352	682	304	64	23	16	32984
1983	4581	5142	9196	3097	1312	895	119	250	108	19	8	24727
1984	13532	3715	3022	4462	1217	655	478	70	140	54	10	27355
1985	4532	11070	2797	1652	2438	536	276	185	29	50	20	23586
1986	21113	3699	6543	1194	785	1150	238	139	62	11	17	34953
1987	7033	17261	2733	3381	515	368	581	142	79	28	6	32126
1988	13652	5746	10835	1461	1782	293	193	325	83	43	16	34430
1989	4101	11169	4418	5624	624	697	112	68	140	32	18	27002
1990	5753	3313	8404	3016	2965	339	293	42	33	69	16	24244
1991	9212	4702	2066	4002	1603	1355	173	130	26	15	36	23321
1992	2723	7512	3198	973	1542	466	407	59	56	5	6	16948
1993	3944	2142	3947	1498	410	457	159	126	26	22	2	12734
1994	2760	3223	1341	1461	503	143	80	32	21	1	3	9568
1995	2066	2257	2469	660	525	192	81	14	4	0	0	8266
1996	3200	1690	1797	1810	432	349	144	62	8	2	0	9494
1997	4815	2616	1346	1256	1122	283	241	107	49	5	1	11840
1998	1769	3939	2019	909	659	506	131	147	71	36	4	10190
1999	4427	1447	3132	1310	566	359	264	84	107	54	29	11780
2000	2610	3622	1128	2078	745	364	238	169	58	86	40	11138
2001	2147	2135	2911	819	1399	494	267	177	128	46	70	10592
2002	2848	1756	1646	1959	490	808	316	192	129	100	37	10281
2003	939	2329	1423	1230	1264	313	530	235	151	103	80	8596
2004	7009	767	1878	1005	758	682	191	360	178	121	83	13032
2005	915	5736	620	1424	683	491	434	123	269	139	97	10932
2006	2571	747	4616	457	992	509	374	320	91	215	113	11005
2007	832	2100	594	3553	304	643	373	290	246	72	175	9181
2008	2368	679	1650	411	2544	221	449	295	230	196	59	9102

Table 2.4. Annual fishing mortality rate for eastern Georges Bank cod using the "Around the Corner" benchmark model formulation (update of Table 14 in the document).

Year	Age Group										
	1	2	3	4	5	6	7	8	9	10	4-6
1978	0.000	0.062	0.465	0.410	0.415	0.499	0.395	0.529	0.648	0.567	0.417
1979	0.001	0.105	0.304	0.452	0.384	0.371	0.176	0.394	0.167	0.361	0.430
1980	0.000	0.152	0.283	0.336	0.442	0.444	0.506	0.238	0.566	0.385	0.420
1981	0.001	0.093	0.346	0.406	0.336	0.581	0.408	0.653	0.880	0.723	0.441
1982	0.001	0.234	0.399	0.682	0.726	0.883	0.805	0.832	1.005	0.862	0.711
1983	0.010	0.332	0.523	0.734	0.494	0.427	0.337	0.375	0.501	0.413	0.623
1984	0.001	0.084	0.404	0.404	0.619	0.665	0.749	0.671	0.830	0.777	0.473
1985	0.003	0.326	0.651	0.544	0.551	0.613	0.482	0.892	0.770	0.875	0.556
1986	0.001	0.103	0.460	0.640	0.556	0.484	0.314	0.370	0.609	0.443	0.562
1987	0.002	0.266	0.426	0.440	0.366	0.446	0.379	0.336	0.397	0.358	0.432
1988	0.001	0.063	0.456	0.651	0.738	0.758	0.844	0.646	0.756	0.668	0.704
1989	0.013	0.084	0.182	0.440	0.411	0.669	0.775	0.510	0.509	0.509	0.460
1990	0.002	0.272	0.542	0.432	0.583	0.471	0.610	0.301	0.631	0.447	0.505
1991	0.004	0.185	0.550	0.754	1.036	1.003	0.878	0.635	1.379	0.758	0.867
1992	0.029	0.443	0.557	0.654	1.017	0.875	0.970	0.621	0.728	0.673	0.876
1993	0.002	0.254	0.790	0.881	0.806	1.544	1.387	1.595	2.908	1.819	0.996
1994	0.001	0.066	0.490	0.804	0.722	0.316	1.555	1.903	6.092	3.546	0.751
1995	0.001	0.028	0.110	0.207	0.195	0.076	0.046	0.261	0.510	0.321	0.184
1996	0.002	0.027	0.156	0.274	0.205	0.156	0.081	0.035	0.246	0.058	0.247
1997	0.001	0.058	0.186	0.435	0.576	0.513	0.252	0.155	0.059	0.145	0.502
1998	0.000	0.029	0.229	0.261	0.386	0.408	0.197	0.086	0.029	0.019	0.337
1999	0.001	0.049	0.207	0.353	0.223	0.190	0.198	0.102	0.001	0.018	0.294
2000	0.001	0.018	0.118	0.191	0.201	0.099	0.086	0.056	-0.020	-0.008	0.183
2001	0.001	0.059	0.193	0.307	0.333	0.227	0.112	0.094	0.021	-0.033	0.306
2002	0.001	0.010	0.089	0.232	0.238	0.204	0.084	0.037	0.026	-0.005	0.226
2003	0.002	0.015	0.143	0.273	0.397	0.275	0.164	0.066	0.019	0.011	0.329
2004	0.000	0.012	0.074	0.177	0.220	0.228	0.208	0.078	0.033	0.011	0.205
2005	0.002	0.016	0.100	0.155	0.090	0.067	0.092	0.081	0.017	0.002	0.121
2006	0.002	0.027	0.058	0.195	0.221	0.103	0.050	0.050	0.020	0.005	0.184
2007	0.002	0.036	0.154	0.124	0.106	0.146	0.030	0.025	0.025	-0.001	0.126

Table 2.5. Beginning of year population biomass (thousands of mt) for eastern Georges Bank cod using the "Around the Corner" benchmark model formulation (update of Table 15 in the document).

Year	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
1978	1376	1836	18395	9770	4247	1889	2073	473	294	111	2	40468	37255
1979	1175	7570	2961	15138	8165	3302	1133	1303	300	139	71	41257	32512
1980	1141	6457	11692	2864	12131	6546	2250	886	943	229	109	45248	37649
1981	2146	6278	9521	11545	2578	9179	4148	1266	750	484	175	48071	39646
1982	777	11791	9818	8827	9687	2168	5069	2571	708	281	264	51961	39393
1983	566	4272	16016	8630	5622	5515	885	2113	1201	234	133	45189	40350
1984	1673	3086	5262	12436	5214	4038	3555	589	1559	659	174	38247	33487
1985	560	9197	4871	4603	10452	3305	2050	1567	323	615	340	37884	28126
1986	2555	2982	11124	3323	3298	7151	1739	1298	861	156	288	34773	29236
1987	1055	14586	4649	9079	2924	2758	4342	947	797	194	97	41428	25787
1988	2078	5347	19343	4414	7431	1835	1629	2839	1026	615	181	46737	39312
1989	583	9291	7532	15515	2688	4486	855	531	1581	330	268	43661	33787
1990	1235	2609	15489	8744	12936	2034	2513	403	451	991	283	47688	43844
1991	808	4217	4031	12676	6803	6633	1306	1309	256	226	486	38751	33726
1992	335	6148	6190	2799	6463	2746	2677	507	559	0	137	28561	22078
1993	277	2045	7247	4369	1822	2654	1073	934	241	188	48	20898	18576
1994	177	2126	1894	3871	2004	1091	615	281	186	21	64	12330	10027
1995	348	1771	3814	1393	1728	959	511	107	45	1	0	10678	8558
1996	146	1276	2799	4634	1726	2134	799	750	100	24	0	14388	12967
1997	536	1886	2256	2728	3581	1807	1626	1210	495	87	24	16235	13813
1998	138	2411	2604	2015	2035	2347	757	1237	584	301	57	14486	11937
1999	691	1489	4178	2855	1688	1668	1831	921	906	913	428	17568	15388
2000	0	3278	1797	4777	2326	1677	1552	1402	664	1192	567	19232	15953
2001	21	1461	4068	2002	5019	2537	1846	1321	1309	449	824	20858	19375
2002	0	744	1934	4517	1760	3565	1878	1622	1294	1179	580	19072	18329
2003	0	419	1469	2198	3906	1089	2777	1600	1154	0	1149	15761	15342
2004	110	175	2732	2346	2787	2917	875	2441	1876	1089	1187	18534	18250
2005	10	3444	731	2421	1984	1655	1721	848	1732	643	1256	16445	12991
2006	83	235	5283	663	2532	1622	1645	1472	520	1486	691	16231	15913
2007	45	1150	622	6619	785	2749	2287	2022	1966	534	1053	19833	18638
2008	101	405	2432	867	6497	808	1891	2343	2316	1545	353	19559	19052

Table 2.6. Projection inputs for eastern Georges Bank cod using the "Around the Corner" benchmark model formulation (update of Table 16 in the document).

	Age Group										
	1	2	3	4	5	6	7	8	9	10	11
Natural Mortality											
2007-2008	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Fishery Partial Recruitment											
2007-2008	0.01	0.10	0.70	1.00	1.00	1.00	0.60	0.40	0.10	0.05	0.05
Fishery Weight at Age											
2007-2008	0.28	0.90	1.61	2.40	3.31	4.25	5.76	6.47	7.24	8.48	11.64
Population Beginning of Year Weight at Age											
2008-2009	0.04	0.49	1.22	1.81	2.56	3.71	4.91	6.51	7.92	7.40	8.35

Table 2.7. Deterministic projection results for eastern Georges Bank cod, "Around the Corner" benchmark model formulation (update of Table 17 in the document).

	Age Group												
	1	2	3	4	5	6	7	8	9	10	11	1+	3+
Projected Population Numbers													
2009	2368	1935	579	1196	282	1762	150	330	228	188	162		
2010	2368	1935	1556	418	818	193	1205	110	252	183	152		
Fishing Mortality													
2008	0.002	0.018	0.129	0.184	0.184	0.184	0.110	0.074	0.018	0.009	0.009		
2009	0.002	0.018	0.126	0.180	0.180	0.180	0.108	0.072	0.018	0.009	0.009		
Projected Population Biomass													
2009	95	948	666	2150	716	6429	740	2143	1780	1371	1326	18363	17320
2010	95	948	1898	713	2080	710	5818	721	1987	1337	1255	17562	16519
Projected Catch Numbers													
2008	4	11	181	63	389	34	43	19	4	2	0		
2009	4	31	59	178	42	259	14	21	4	2	1		
Projected Catch Biomass													
2008	1	10	292	150	1288	143	245	123	28	14	6	2300	
2009	1	28	95	426	139	1101	81	134	26	13	15	2059	

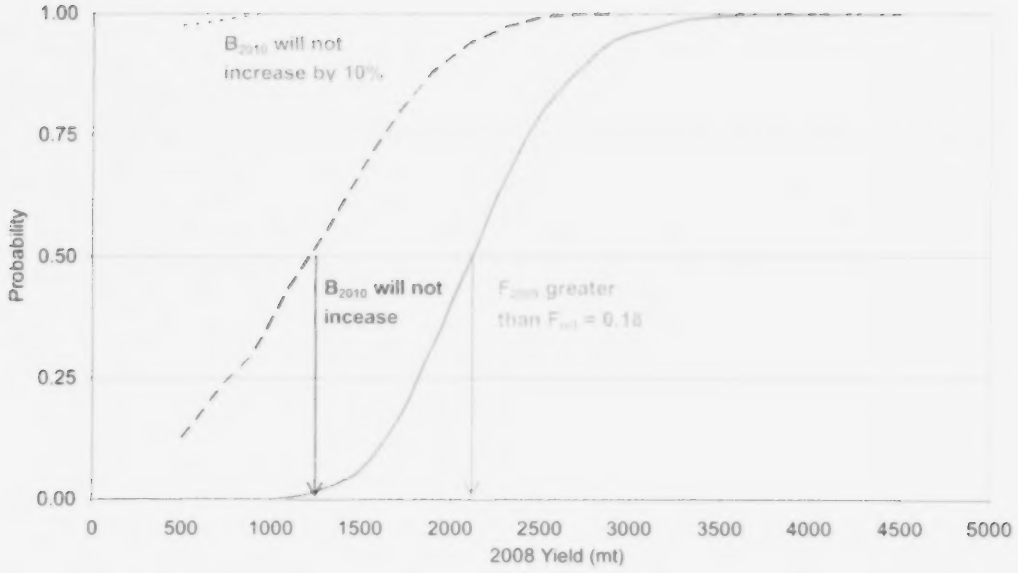

Figure 2.1. Risk of 2009 fishing mortality exceeding F_{ref} = 0.18 and risk of biomass not increasing or not increasing by 10% for alternative total yields of eastern Georges Bank cod, "Around the Corner" benchmark model formulation (update to Figure 43 in the document).